SCIENTIFIC AMERICAN

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NEW YORK, MAY 22, 1909.

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Ten days' rations of the American army graphically shown. For comparison a locomotive is shown in the foreground, also one of the 70,000 units that consume this enormous quantity of food.

FEEDING THE AMERICAN ARMY.—[See page 390.]

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ESTABLISHED 1845

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NEW YORK, SATURDAY, MAY 22d, 1909.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

THE TURBINE THE COMPLEMENT OF THE COMPOUND ENGINE

In a discussion at the last meeting of the Institution of Naval Architects in England of the best method of combining the reciprocating engine and the steam turbine in the propulsion of steamships, the proposition was made that the best results would be obtained if the reciprocating engine were of the compound type. In a recent discussion of this subject in the Shipping World, a member of the Institution claims that the consumption of 100 pounds of steam per hour at an initial pressure of 10 pounds to the square inch would give 2.4 horse-power in a reciprocating engine, and 4.18 horse-power in a turbine. The wide difference between 2.4 and 4.18 horse-power can, of course, be secured only when the steam is of low pressure.

We have already pointed out in this journal that the impossibility of carrying the expansion in a reciprocating engine down to the low point that is possible in a turbine, is due to the fact that the low-pressure piston would have to be of such enormous size and weight, that the additional power secured by the increased expansion of the steam would be used up in overcoming the increased friction due to the heavy moving weights. In tramp steamers, and all steamships with a full model at the stern, it is advisable to use a large propeller running at a low rate of revolution. In a triple-screw vessel of this class, it is suggested that the best arrangement would be to use a compound reciprocating engine for the center propeller, and propellers running at a high speed of revolution driven by two turbines in the wings. We understand that in the new White Star liners "Olympic" and "Titanic," which, however, are vessels of fine form, the wing propellers will be driven by reciprocating engines, and the center propeller by a low-pressure steam turbine.

FUTILE CRITICISMS OF THE LOCK CANAL.

During the interval which has elapsed since the indorsement by an expert board of engineers of the plans upon which the lock canal at Panama is being built, we have made it a point to read much of the literature which has appeared in condemnation of the lock canal and in favor of one at sea level. This criticism has been distinguished more by the frequent, we had almost said the invariable, anonymity of the writers than by any originality in the arguments set forth. Why this modesty, and why should "An Engineer" or "An Eminent Engineer," or a "Specialist in Canal Construction" withhold from the public the immensely increased weight which would be given to his arguments by the publication of his distinguished name?

We have read these letters, mainly in the hope that some new facts might be presented which had hitherto been overlooked, and which would have a serious bearing upon the question of the relative value of the two types of canal; but we have to confess that we failed to find anything more than a wearisome reiteration of theories and propositions, and very little pertinent criticism of the actual facts as they were clearly set forth by the late Engineering Board.

The four great questions to be answered in a comparison of the two types of canal are, first, as to practicability of construction; second, as to time of construction; third, as to cost; and, fourth, as to speed and safety of navigation.

As to the practicability of the lock canal there is not a single element of the engineering problems involved which has not been subjected to a larger amount of preliminary experimental investigation than has been applied, probably, to any previous engineering work of magnitude in the history of the world. In every case, the outcome of these investigations has been to establish, in a most emphatic way, the feasibility of the proposed method of construction. With regard to the sea-level canal, on the other hand, there are several questions, most vital to the security of the canal, which have received practically no investigation, and against which there is at present a very serious element of doubt. Regarding the questions of time and cost, it is now known that it would take six years' more time and $200,000,000 more money to build a sea-level canal, and this canal, when it was finished, would provide a channel only half as wide as the narrowest width of the channel of the lock canal. And, lastly, regarding the question of speedy and safe navigation, it has been shown, and never disputed, that the lock canal will provide a navigable channel three hundred feet wide in its narrowest section, which, by the way, extends for only about one-seventh of its total length, and that for the other six-sevenths it will be from five hundred to one thousand feet wide. The sea-level canal, except for a few miles of 500-foot width at each entrance, would consist of a narrow and tortuous channel, never over 150 feet in width. Practically every navigator who has passed upon the merits of the two canals from the standpoint of the pilot house, has pronounced emphatically in favor of the lock canal.

Meanwhile, in spite of the efforts of a few contractors, disappointed promoters, and pseudo-engineers, to raise a tempest upon the deep waters of the correspondence columns of the daily press, the work of building the lock canal at Panama moves forward at an ever-accelerating rate. The last report of the chairman of the Isthmian Canal Commission, covering the month of March, shows that the grand total of all previous monthly excavations has again been exceeded, the total amount removed being over 4,000,000 cubic yards. This rate of excavation is not far from double the rate which was expected when the estimates for the present lock type of canal were made. Furthermore, a recent dispatch from Col. Goethals states that the total amount of excavation done since May 4th, 1904, when the United States began the work of construction, has been 73,124,849 cubic yards; and that of this total over one-half, or 38,059,180 cubic yards, was taken out in the last twelve months. There yet remain to be excavated 101,541,746 cubic yards. The building of the Gatun dam and concrete locks will be the controlling time-factor in the question of final completion, and the indications are very favorable for the opening of the canal on, if not before, January 1st, 1915, the date set by the Chief Engineer.

CONDITIONS OF THE BATTLESHIPS AFTER THE LONG CRUISE.

A correspondent, writing from one of the far Western States, incloses a clipping containing extracts from an article reprinted from a New York paper in which it is stated that the voyage around the world "practically wrecked the ships which took part in it"; and that the present extensive alteration to the upper works of the ships is being done to remedy certain serious defects that were discovered during the cruise. Our correspondent asks to be told whether the facts are as stated.

The facts are not as stated; nor is there a word of truth in the whole story. We would not take the trouble to refer to this false criticism were it not that the report seems to have originally emanated from Washington, and to have sprung from the same source and the same city from which has come so much of the destructive criticism of our navy during the past two years.

How maliciously untrue is this story is shown by the fact that the sixteen battleships that made the cruise returned in absolutely first-class condition, and that the repairs which are strictly chargeable to the cruise are a mere bagatelle as compared with the annual cost of maintaining the ships for the same period of time. At the New York yard there are at the present time for overhauling, the battleships "Rhode Island," "Nebraska," "Connecticut," and "Ohio." The repairs on these ships that are traceable to the cruise, and come outside of the regular repairs incidental to the periodical overhauling, will not average over $20,000 for each battleship. This low figure, be it remembered, covers continuous service for a period of over a year, and on a course that reached for 45,000 miles through the seven seas. The cost of maintaining a battleship in commission during ordinary service, for one year, is about $300,000; and that such extraordinarily severe service should have involved so small an extra cost for repairs must be considered a most creditable record, and a high tribute to the excellence of the ships. The most conspicuous evidence of wear and tear was in the linoleum with which the steel decks are covered; and this was due to the coaling and ceaseless tramping to and fro incidental to the multitudinous duties of life at sea.

The structural changes, which are almost entirely confined to the upper works, are not in any sense due to lessons learned during the voyage, and certainly they are not to be regarded as a "remedying of glaring defects and suddenly revealed weaknesses." As a matter of fact, the work was recognized as advisable long before the fleet started on the cruise. The principal changes are the removal of bridges, the taking out of the old military masts and the substitution for them of the new circular latticework masts for carrying the fire-control platforms. The after bridge and its associated armored signal tower have been removed, and the forward bridge has been greatly cut down. The extensions of this bridge on each side of the conning tower are now so arranged that they can be quickly removed in time of battle, the captain of the ship being henceforth compelled to take his station within the conning tower, where he properly belongs. By the removal of top hamper it will be possible for the captain to command the horizon, except through that arc of it which is shut out by the smokestacks.

This change will remove one more of the picturesque and popular episodes of the earlier days of sea fighting. The captain will no longer fight his ship from the flying bridge and in the open. The conning tower was built for him, and a due regard for the issues of the battle demands that he remain within it. It was the death of Admiral Vithoft of the "Czarevitch" that threw the Russian line into disorder in the great sortie from Port Arthur, at the very time when the chances of shaking off the Japanese seemed favorable. The captain of one of the battleships in that fight told us that the Admiral was struck by a shell, as he was leaning with folded arms upon the railing of the bridge watching the Japanese line. That shot also wrecked the conning tower, it is true; but the latter was of a design which would not be considered in our own navy.

In addition to the removal of top hamper, the whole of the accumulated layers of old paint throughout the ships is being removed; and in future, with a view to further reducing weights, no ship will be allowed to carry an accumulation of stores beyond the regular six months' supply. As showing the absurdity of the statement that the structural changes mentioned above are being made in order to bring the "deeply-laden ships" up to a lighter draft, it may be mentioned that when the alterations are completed, the draft will be only from ¾ inch to 1½ inches less than before.

The cruise was a splendid thing for the ships themselves. Of this the public may rest well assured. There is no surer way in which to insure rapid deterioration of a ship than to keep her moored in harbor. Conversely, there is no better way to maintain a warship in first-class physical condition than to keep her constantly on the move.

ORNAMENTATION IN LAKE-DWELLERS' HABITATIONS.

Traces of ornamentation have been found upon the remains of lake-dwellers' huts, which seem to show that these were ornamented on the outside by designs in relief. Such designs were executed upon the outer clay covering which was placed on the timbers of the structure, and they were cut or imprinted in the clay while it was still soft. However, such ornamentation is not to be found on all the lake-dwellers' habitations with which we are acquainted, and the only traces of it come from the Bourget lake in France, not far from Switzerland. Fragments of clay containing the ornamentation are now at the Chambery museum, and they have been examined by M. L. Schaudel. According to him, they consist of lines traced by a pointed tool, forming rectangular or circular bordering which contains stamped ornaments. These latter are made up of three concentric circles and seem to have been stamped in the soft clay by a terra-cotta mold. One of such molds was found at the Gresine lake-dwelling site. It is supposed that the dwellings were covered with clay on the outside, as all these dwellings had been destroyed by fire, and the specimens were intact on the ornamented side and blackened by smoke and partly baked on the other side. Had the clay lining been placed on the inside, no doubt the whole of it would have suffered. Besides, as the only light came from the door, the inside of the dwelling must have been very dark and there would be no reason for the ornamentation. M. Schaudel brings out some other points about such dwellings, which were determined from the remains discovered in a peat bog near Schussenried, Switzerland, by M. Frank. The dwelling was of rectangular shape about 30 feet long and 22 feet wide, and was divided into two rooms. The walls were made of oak trunks which were split in half, the flat side being placed next the interior, the cracks being stopped by means of a thin coating of clay. The floor was formed of several layers of split wood and clay. A fireplace was found in the smaller room, which no doubt served as a kitchen, while the larger room was probably used as a sleeping room. The latter had no outside door, and the single door was placed in the smaller room. A number of main timbers or piles were sunk in the lake bottom and also upheld the roof.

ENGINEERING.

Reports from Washington regarding the lengthy cruise recently completed by the United States steamer "Cheyenne," in which oil was used as fuel, are to the effect that the vessel was able to steam faster than with coal, and that her steaming radius of 1,500 miles, which was her limit when burning coal, has been increased by the use of oil to 2,300 miles.

The final plans are now being prepared at Twin Falls, Idaho, of what the engineers claim will be, when completed, the highest bridge in the world. It will serve to carry the tracks of an electric road across the Snake River Canyon at a point a short distance below the Great Shoshone Falls of that river. The under side of the bridge will be 700 feet in the clear above the water.

The Ambrose Channel entrance to New York harbor, which, when completed, will be 2,000 feet wide and 40 feet in depth, has now been excavated throughout its whole length for a width of 1,000 feet. It will take about two years and a half to finish the whole work. The completed portion has shown none of that tendency to silt up which was predicted, and it seems likely that the scouring action of the tides will serve to keep the channel permanently clear of shoals.

Atlantic steamship records to the eastward were improved by the "Mauretania" on her last trip, when the distance from Sandy Hook to Daunt's Rock was covered in 4 days, 18 hours, and 11 minutes, at average speed of 25.70 knots. The daily runs were 588, 605, 610, 600, and 532 miles. For three days, from Thursday noon until Sunday noon, the average speed was 26.3 knots, and on the day when 610 miles were covered, the average speed was 26.5 knots.

The Chicago, Rock Island & Pacific Railway is one of several of the leading railroads in the West which have equipped certain sections of their roads with telephones for train dispatching. Last August that road introduced telephone dispatching on its Selina branch, 50 miles in length, and later put the same equipment on 80 miles of road from Herington to Topeka, one of the busiest sections of the Rock Island Railroad. The results were so satisfactory that the company have now equipped the most important division of their road, between Blue Island and Rock Island, consisting of 165 miles of double track, with dispatchers' telephones.

The system of building embankments, by running trains of loaded cars on rails hung from a suspension cable above the line of the embankment, is being used with great success, notably on a long and high embankment on the Lake Hopatcong cut-off of the Delaware, Lackawanna & Western Railway. Two cables are strung from a fixed to a movable tower, and suspenders from the cables are attached to the floor beams of a portable track, which is carried forward ahead of the completed embankment a sufficient distance to allow a train of dump cars to be run upon it and emptied through it. The new method is more speedy and costs less than the old system of building a trestle and burying it in the embankment.

The auxiliary survey yacht "Carnegie," which is being built at the Tebo Yacht Company's yard, South Brooklyn, is making good progress. The hull is in frame, the deck beams in place, and about one-half of the ceiling and planking is done. It is expected that the launching will take place during the last week in May, and that the yacht will be completed about the Fourth of July. Immediately after her trial trip she will start for Hudson's Bay, and commence to make a series of magnetic observations along the proposed route of a new steamship line from Churchill to Liverpool. In the autumn, after her return to this city, her bottom will be sheathed with yellow metal, and she will then be ready for her cruise in southern waters in 1910. The yacht is 155½ feet in length over all, and is built of strictly non-magnetic materials. She was illustrated and described in our issue of February 20th, 1909.

The present condition of work on the Pennsylvania tunnel system in New York is as follows: The excavation and concrete lining of the Bergen Hill tunnels are practically completed. The excavation of the tunnels beneath the Hudson is also nearly finished, and a large part of the concrete lining is in place. The terminal station at 33d Street has received its granite facing on all four façades, and most of the steel structure of the station has been built in place. The four tunnels beneath Manhattan Island have been lined with concrete, and are ready for the laying of tracks. The tunnels below the East River have been completed, and the terminal work in Long Island City is well under way. During the current year the electrification of the system, track laying, signaling and interlocking, etc., is being actively prosecuted; and the indications are that the whole work will be completed during the summer of 1910.

ELECTRICITY.

The Ohio State University is about to start a class in its Engineering Department for the teaching of wireless telegraphy. A complete wireless telegraph equipment is to be installed, and will maintain communication with stations at Cleveland and Detroit.

The Illinois Central Railroad is adopting the telephone for train dispatching. The Superintendent of Telegraphs states that within a year all the main lines will be dispatched by telephone. The Burlington line is operating 1,400 miles in this way, so that it may be said that the telephone for train dispatching has passed the experimental stage.

A new form of arc lamp has just been devised, in which carbon disks are used instead of carbon rods. These disks are constantly rotated, and the arc takes place between the peripheries of the disks. Owing to the continuous rotation, the disks are consumed uniformly. The lamps are small as compared to the ordinary type. The size of a 10-ampere lamp is but 20 inches over all. It is claimed for this lamp that it will burn 50 per cent longer than the rod type.

The first lot of electric locomotives to be used by the Pennsylvania Railroad in its tunnels through New York have just been ordered of the Westinghouse Electric and Manufacturing Company. These locomotives are to be the most powerful ever built. Each will consist of two units, and each unit will be equipped with a 2,000-horse-power motor. The locomotives will be capable of running at a rate of 90 miles per hour. Two of them will be ready for a test this fall.

One of the objectionable features of the ordinary street cars in large cities is the fact that they are provided with leather hand straps, which are liable to accumulate dirt and disease. As a substitute for these unsanitary straps a steel hanger has recently been devised, which is covered with porcelain enamel, so that it may be kept absolutely clean. These straps are being tried by the Interborough Rapid Transit Company of this city.

A new axle train-lighting system has recently been devised, in which the generator is located in the baggage car of the train. The generator is placed in the body of the car, where it is open to inspection at any time, and it is driven by belts from the axle of one of the trucks. The belts are made self-adjusting, so as to take up slack due to the flexing of the springs. A storage battery which is charged by the dynamo serves to furnish current for the lights when the train is standing still.

A novel musical instrument has recently been exhibited, which resembles a piano, but the wires, instead of being struck with hammers, are vibrated by means of electro-magnets. The instrument is also provided with ordinary piano keys and hammers, so that it may be operated by them alone, or at the same time by hand and by the electro-magnets. It is said that the tones of the instrument, which is known as a choralcelo, resemble those of a stringed instrument and organ combined.

A press message was recently sent by the New York Times to the Chicago Tribune by means of wireless telegraphy from the tower of the Waldorf-Astoria Hotel to the Auditorium Annex in Chicago. The difficulties involved in sending the message, owing to the interfering and conflicting waves from other stations, showed that wireless telegraphy, at least in its present state, is not a serious competitor of wire telegraphy for transmission over land. It was only after repeated attempts to get the Chicago station that communication was finally established.

According to a recent press report, a new system of wireless telegraphy has just been completed by the German Telefunken Wireless Telegraph Company. The system goes by the name of "singing sparks," and it is claimed for it that it produces continuous oscillations. How this system differs from the singing arc is not explained. If a system has been evolved by which continuous oscillations may be maintained with perfect regularity, the value of it would be even greater for wireless telephony than for wireless telegraphy, as it would enable one to send spoken messages over a much longer radius than has hitherto been possible.

A new lamp for use in mines has recently been invented. The lamp is placed within a large glass globe, which is air-tight. Between the lamp and the globe pure air is inclosed, and when the lamp is lighted, the air is expanded by the heat. In case the lamp should be so injured as to expose the incandescent filament to the gases in the mine, the compressed air between the two globes is driven into the broken lamp before the air of the mine can enter. The influx of compressed air extinguishes the lamp before the explosive air of the mine is able to reach it. The lamp is fed by a single-cell storage battery, which is inclosed in a celluloid case. It will burn for twelve hours on a single charge, and gives a light of between one and two candle-power.

AERONAUTICS.

On May 6th Lieut. Calderara, the Italian naval officer whom Wilbur Wright taught to operate his machine while in Italy, became dizzy while making a flight, and slipping from his seat, fell a distance of 45 feet to the ground, luckily without sustaining fatal injuries. Deprived of its aviator, the aeroplane crashed to the earth and was badly damaged. This unusual mishap of Lieut. Calderara shows the need of an automatic control, which, should anything happen to the man at the helm, will keep the machine flying on an even keel in the direction in which the rudder is set. With the aviator strapped to his seat, the aeroplane would keep going till the fuel gave out, when it would probably land without damage.

In all probability the Aeronautic Society will be the first American organization to own a Wright aeroplane. Upon their arrival at New York negotiations were at once opened with the Wrights for one of their machines, a few of which are being made by them at Dayton, Ohio, for customers in this country. Though loath to take further contracts at present, both brothers thought they might be able to supply the Society with a machine and to teach a member to operate it within the next two months. The average automobilist can be taught in ten 15-minute lessons, according to the results obtained abroad in this line. The price of the machine is $7,500. With this and the $7,500 Curtiss aeroplane, together with its Morris Park race track aerodrome over which to fly them, the Aeronautic Society offers advantages for those interested in practical as well as experimental aviation to be found nowhere else in the world. The opening flight exhibitions will probably be held May 29th and 31st.

The Wright brothers were entertained at luncheon by the Aero Club of America at noon on May 12th. Several congratulatory speeches were made by the acting president, Mr. A. Holland Forbes, and by Messrs. Colgate Hoyt, Charles J. Edwards, and Gen. Bingham, Police Commissioner of New York. Both the brothers were congratulated on their achievements, and all the speakers mentioned the disgrace put upon our government by the failure of Congress to appropriate the $500,000 which was asked for by Gen. Allen for aeronautic purposes. Upon reaching Dayton, Ohio, their native city, the Wrights were given a preliminary ovation by the citizens, who, on the 16th and 17th proximo, expect to give them a special celebration, at which time they will probably make exhibition flights. On June 10th, at Washington, President Taft will present the gold medals given by the Aero Club of America and also the Smithsonian medal and the medals given by Congress. Orville Wright will probably carry out the completion of the government contract at this time.

The members of the Signal Corps at Washington recently inflated "Dirigible No. 1." The airship was in its shed fully inflated, and the tent had been erected near by to receive it, when a heavy thunder shower suddenly sprang up. The wind blew down the tent, and a bolt of lightning apparently passed through the balloon shed, going in one door and out the other, while several officers were present. Fortunately, the hydrogen gas was not ignited. On account of lack of facilities, it was decided to deflate the dirigible and take it to Fort Omaha, Neb., where there is an excellent large shed and a complete plant for making hydrogen gas electrolytically. The gas has been transferred to the army balloon, and several ascensions have been made. With the taking of the dirigible to Fort Omaha, the army aeronautic work in the balloon line will be removed from Washington, but the tests of the Wright and Herring aeroplanes will be resumed at Fort Myer next month.

Mr. J. A. D. McCurdy, the secretary of the Aerial Experiment Association (which has lately disbanded), was in New York recently. He stated that during the past winter he has flown more than 1,000 miles, having made over 100 trips over a 9-mile course, carefully measured and staked out upon the ice of Lake Bras d'Or. The machine used was the "Silver Dart." Messrs. McCurdy and Baldwin, of the A. E. A., have formed a company to manufacture similar machines in Canada. They have already nearly completed two aeroplanes similar to the "Silver Dart." Among other things, Mr. McCurdy rather upset the theory of wind gusts affecting an aeroplane in flight perceptibly, by stating that in his flights in Canada he had passed over promontories and near hills without having his machine affected in the least. At one time, when flying at Hammondsport, the end of one wing struck a branch of a tree as big as a man's arm, and broke it off, without having the equilibrium disturbed. In view of the above, and also of the practical demonstrations of cross-country flight already made by Farman and Bleriot, it does not seem probable that slight aerial disturbances will stop a machine from following the course of the Hudson River from New York to Albany, and winning the Fulton Flight, in case the motor does not give out.

KAEMPER'S DISCOVERIES IN THE MAMMOTH CAVE.

BY DR. HORACE C. HOVEY.

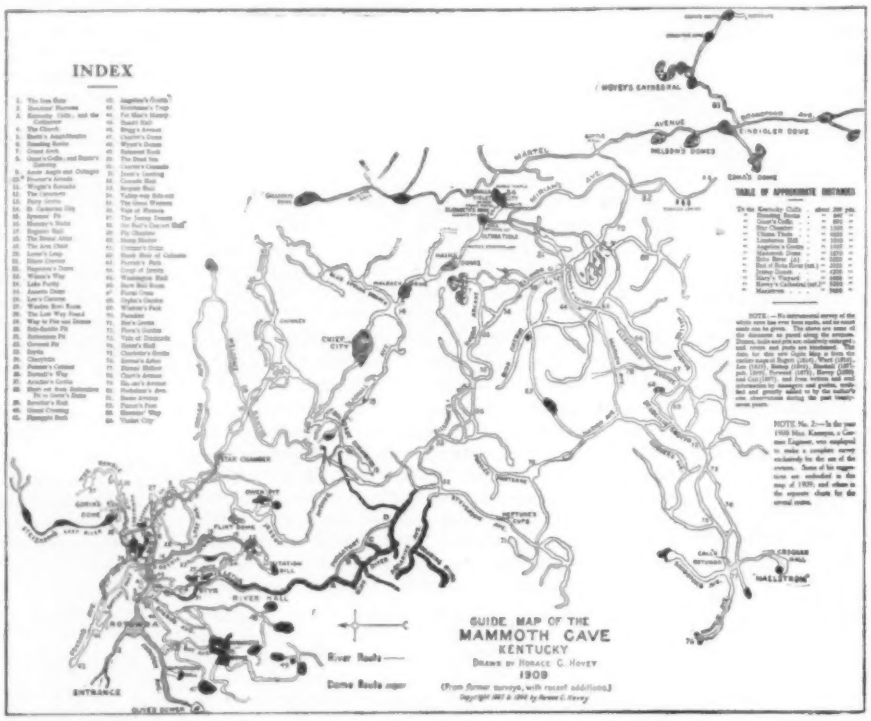
Clippings have been received from many newspapers to the effect that, because of the drought last summer, the Echo River, the Styx, and other waters in Mammoth Cave had dried up, thus making possible, as never before, great discoveries in regions before unknown. This false report is all the more exasperating for the reason that really the underground waters have been higher than formerly on account of the setting back of Green River, in consequence of a series of dams and locks built by the government in the interest of navigation. All underground voyages are more difficult than they used to be; and certain locations once accessible are now closed by permanent inundation. An example of this is Stevenson's Lost River, now occluded, on which Mr. F. J. Stevenson, of London, once sailed for seven hours in a boat that is still visible stranded on the floor of Gorin's Dome.

In my frequent trips through Mammoth Cave last November, when the long drought was at its height, I found no indications that the cave waters had fallen more than is usual in summer, and I had an especially delightful sail on the deep, limpid waters of Echo River, whose marvelous arches rewarded shout and song by as wonderful reverberations as ever.

But it is perfectly true that remarkable explorations have been recently made, not because of the drought, but by reason of the systematic, skillful work done by Max E. Kaemper and Edward Bishop. To appreciate their work it must be understood that all published maps of the cave, including my own, were made under difficulties, without any general instrumental survey, which was allowed only in certain portions.

Max Kaemper, whose name must be henceforth identified with Kentucky's greatest cavern, came from Germany to America to acquaint himself with American manufactures and mining methods, and also to learn the English language. After six months in the city of New York he took a trip, early in 1908, through the South and West, in the course of which he visited Mammoth Cave, with no thought of staying in its vicinity more than a week. But his week grew into a month, and then into a period of eight months, during which his thoughts by day and night were on the mazes of the cavern.

In his first subterranean visits he was guided by my map of 1907, following whose courses he made his way to Hovey's Cathedral (described in Scientific American Supplement, August 27th, 1907). He discovered that there were at least three different ways to this locality, besides the one taken by Mr. Einbigler's party, and later by myself. Then he pressed beyond the Cathedral to other domes, pits and grottoes. More than once he came across the name of Creighton carved on the limestone rocks—a man unknown to the cave owners. In honor of this early and unknown explorer he named a large room "Creighton's Dome." To another still farther beyond he gave his sister's name, calling it Gerta's Grotto. These localities and some other discoveries are indicated on my new guide map for 1909.



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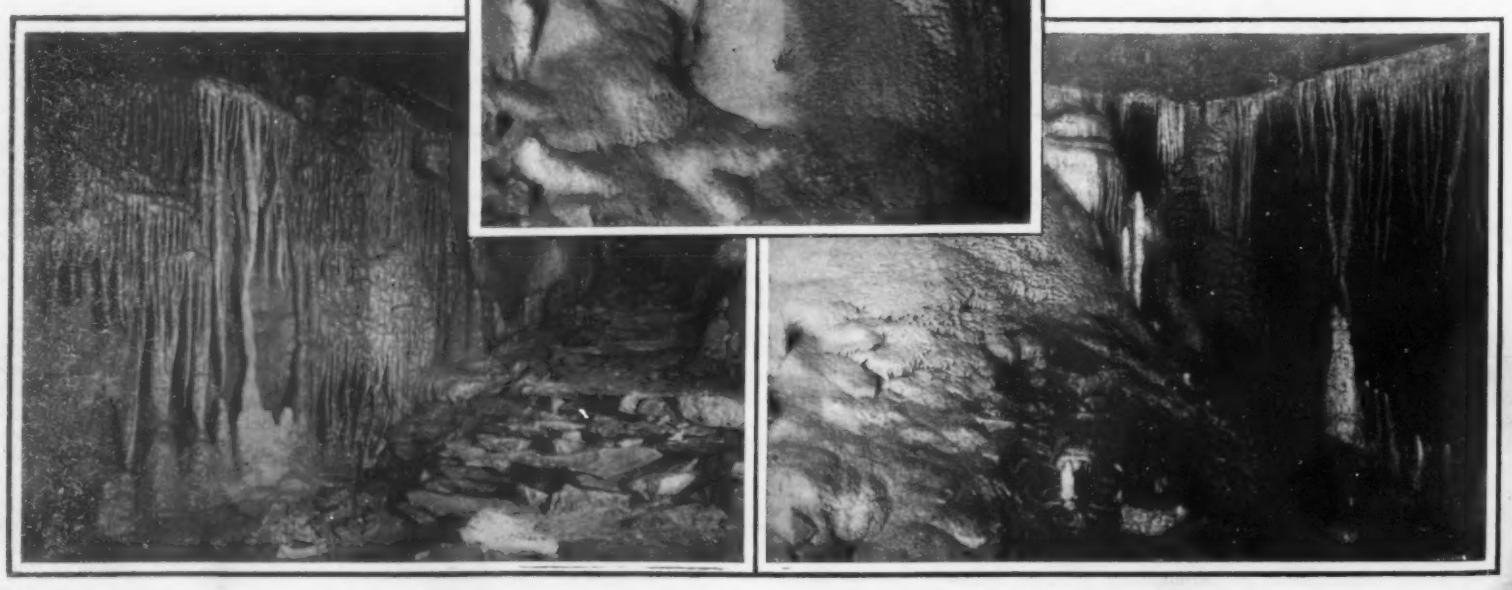
Dr. Hovey's guide map of Mammoth Cave.

Those in local authority at Mammoth Cave began to feel that this young man was possibly learning too much about the cave, and they threw discouragements in his way. But at the suggestion of Mr. H. C. Ganter (who formerly had been for many years local manager), the controlling trustee, Judge Albert Covington Janin, of Washington, D. C., gave permission for Mr. Kaemper, not only to explore to his heart's content, but to go ahead and do what many have long felt should be done, namely, make a complete survey of the entire cavern. Accordingly it was done.

When the time arrived to terminate this great undertaking, Judge Janin did me the honor to invite me, as a veteran cave man, to visit Mammoth Cave, and see what had been accomplished.

I did so last November. I found an honest young German, about twenty-three years of age, an admirable draftsman, a fearless and capable explorer, and one ready to answer any questions put to him. He told me frankly that the dimensions of the cavern were too great to warrant any general method of measurement other than pacing, to which he had been trained in military service. He also said that he had taken no barometric observations. He used a good surveyor's compass for taking bearings in the main cave and principal branches, but relied on a pocket compass for the narrower passages and crawlways. Though taking Edward Bishop along as his constant guide, he relied altogether on his own bearings and distances for direction and never once lost his reckoning. His plan was to take the Main Cave and the Long Route as a kind of base line, from which to branch out in every direction. In every instance he followed any given passage to its remotest end, completing his sketch as he went along. Incidentally, his guide, Edward Bishop, the grandnephew of the famous Stephen Bishop, served as his daily teacher in conversational English, with a result highly to the credit of both instructor and scholar. It was my earnest wish that the entire map thus patiently made by Mr. Kaemper might be given to the world. But the management, for prudential reasons, courteously decline to do this at present. The most that they have consented to do is to let me publish special sketches of the routes ordinarily taken by visitors, and to allow me to consult with Mr. Kaemper in the revision of my own guide map for 1909, with a few corrections and additions. Thus it still remains true that the latter is the best guide map extant or that will probably appear for some time.

(*Concluded on page 390.*)



"The Chimes" in Mammoth Cave. The Marble Temple. In "Violet City."

Photographs copyright 1908 by H. C. Ganter.

NEW DISCOVERIES IN THE MAMMOTH CAVE.

A WONDERFUL MODEL OF THE STRASBURG CLOCK.

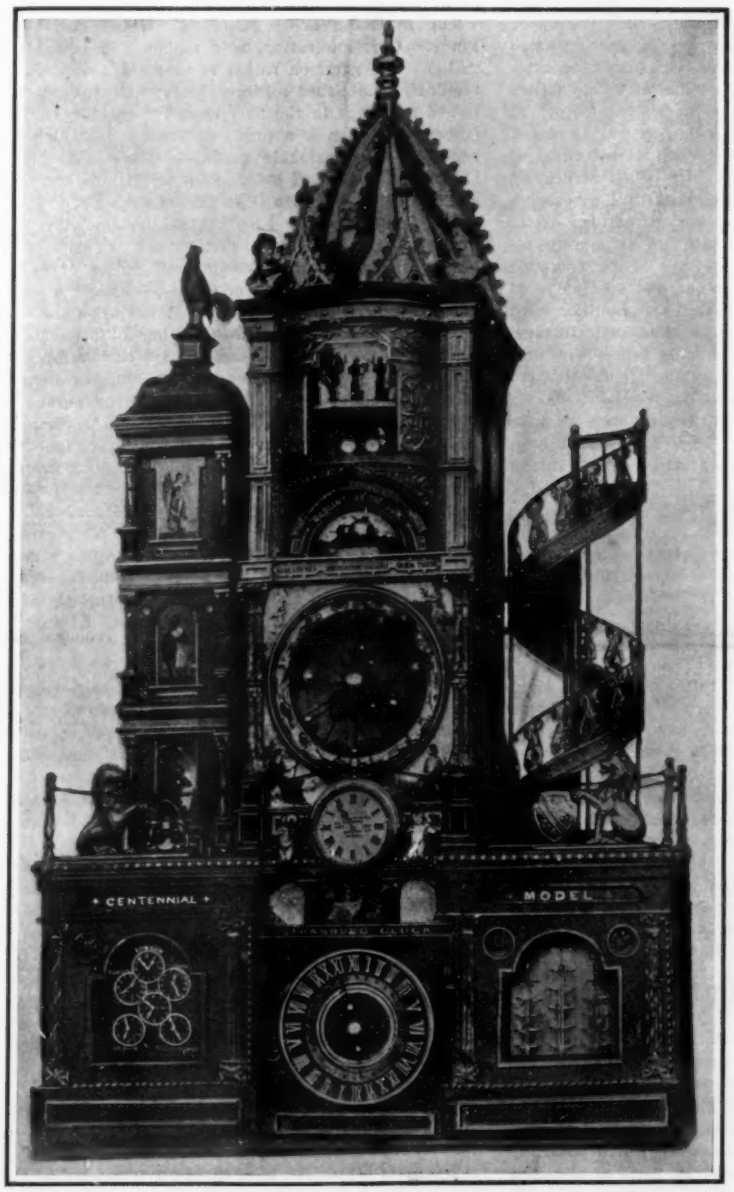
In the Technological Museum of Sydney, Australia, is a working model of the famous Strasburg clock, which has been running for twenty years. The mediæval original is considered one of the wonders of the world. Mr. Richard B. Smith conceived the idea of making a model of this clock. He began the task on January 26th, 1887, the ninety-ninth anniversary of the discovery of Australia, his native country, and completed it at the end of 1889.

The work is all the more remarkable, because Mr. Smith has never seen the original Strasburg clock and could find no accurate description of the mechanism. The books simply told him what functions the clock performed, and he set about the task of building a clock which would perform all the functions of the original and others in addition. For that reason the operative mechanism of Mr. Smith's clock probably differs from that of the Strasburg clock. Every part of the mechanism as well as the outer case (with the exception of the carvings and paintings) was made by Mr. Smith himself.

The Strasburg case is built of marble, and stands sixty feet high. The case of the model is constructed of cedar and is twelve feet high. In the first alcove in the central tower the procession of the twelve Apostles takes place. As the clock strikes twelve an organ is heard playing sacred music. The doors on the right of the alcove are seen to open and the first Apostle, Andrew, appears. As he comes forth the doors swing open and the figure of the Saviour emerges. Andrew turns as he reaches the center and bows his head. The Saviour responds with a bow and raises his hand in salutation as each Apostle passes by, until the sixth Apostle—Peter—appears. As Peter comes forward Satan appears in a window to the left. He lifts his hand and tempts Peter, who turns his back on the Saviour. Simultaneously the cock on the weight tower flaps his wings and crows three times, in celebration of Peter's steadfastness. The other apostles pass by the Saviour and bow. When Judas approaches, Satan appears again and tries to tempt Judas, who pretends to be more faithful and bows more lowly.

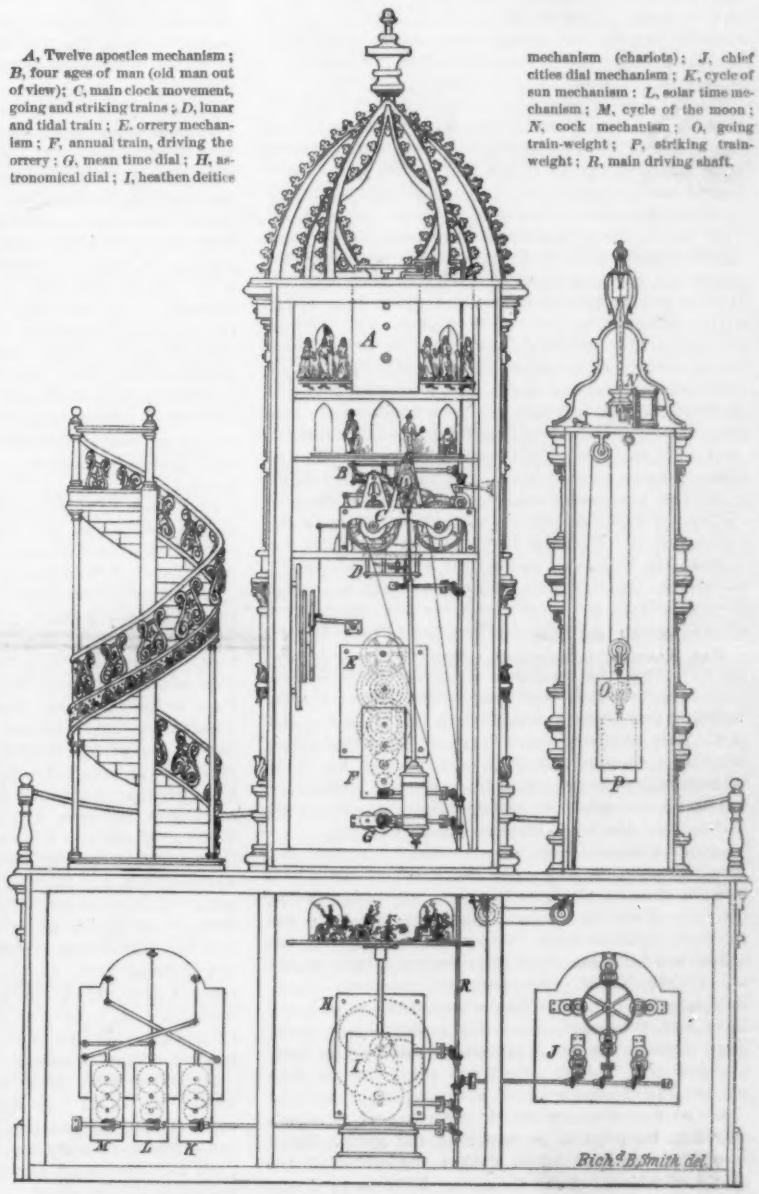
In the alcove beneath are the four ages of man. At the first quarter of the hour a child is seen with a ball in its hand. At the close of the quarter the child moves on, and in so doing he strikes a bell on the right once with his ball. At the second quarter of the hour a youth appears with a bow and arrow. As the quarter closes, the youth walks on and strikes the bell twice. At the third quarter a huntsman appears who, as he passes away, strikes the bell with his gun three times. At the fourth quarter an old man appears who strikes the bell four times with his stick. A skeleton in the background strikes the bell once on the left—a death knell indicating the close of life. Next is seen a sphere within a semicircular niche, which represents the moon, one half black, the other silvered. The sphere shows the phases of the moon as it revolves in 29½ days. Beneath this sphere Mr. Smith has introduced in his model a tidal dial which shows the rise and fall of the tides, a feature not to be found in the original clock at Strasburg. Around the niche containing the sphere is the English equivalent of the German inscription: "What is there equal to the dawn, beautiful as the moon, radiant as the sun?" Beneath this we read: "Deus Lux Mea Quem Timebo." (God is my light, whom shall I fear.) The dates 1838-1842, between which the old clock in Strasburg was reconstructed, appear between the Latin and English inscriptions in the center of the main case. Beneath the date is a grand golden orrery on the Copernican system. In the center of the orrery is a large gilded ball representing the sun, around which the solar system revolves. The planets are represented by ivory spheres. The nearest ivory planet to the sun, Mercury, revolves in 87 days 22 hours. Next come Venus, revolving in 225 days, the earth in 365 days 5 hours 45 minutes 48 seconds, Mars in 687 days, Jupiter in 12 years, and Saturn in 29½ years. Those are the six primary planets, all that are shown in the original clock. Mr. Smith has added Uranus in the model, which planet revolves in 87 years, and also Neptune, which has a period of revolution of 164 years. Below the orrery is the dial showing mean time. On each side of the dial is a cherub, one of whom strikes the quarters and the other of whom turns the hour glass. Beneath the dial are the seven ancient deities representing the days of the week, Apollo (Sunday), Diana (Monday), Mars (Tuesday), Mercury (Wednesday), Jupiter (Thursday), Venus (Friday), Saturn (Saturday). In the center of the clock at its base is the grand astronomical dial, showing the apparent motion around the earth of the sun, moon, and stars from the first to the fifth magnitude. The original clock at Strasburg shows a planisphere of the northern hemisphere, while Mr. Smith's dial shows the southern hemisphere. The dial shows the times at which these bodies rise, south, and set, the age of the moon, and its phases, the date, the time of day or night, and the signs of the zodiac, through which the sun and moon pass during the year. To the right of this dial is shown the cycle of the sun, which shows the position of the sun in the constellations every 28 years. At the end of this cycle the sun is in the same position as it was in the beginning and in the same constellation. The central dial indicates solar time, and shows when the sun passes the meridian. Thus on April 15th, June 14th, August 31st, and December 25th it passes the meridian precisely at noon. At other times it varies from 16 minutes to noon to 15 minutes past. The next dial shows the cycle of the moon, which is 19 years. All the phases of the moon appear on the same day and date as they did 19 years before. To the left of the astronomical dial in the original Strasburg clock the feast and fast days of the church are indicated. Instead of these Mr. Smith's model shows the time in some of the chief cities, New York, London, Dublin, Berlin, and St. Petersburg.

There are a number of oil paintings on the case. Those around the orrery represent the four seasons. Around the astronomical dial are paintings of the four kings Clovis, Dagobert, Charlemagne, and Louis



A one-fifth scale model of the famous Strasburg clock which performs all the functions of the original clock and others besides.

A, Twelve apostles mechanism; *B*, four ages of man (old man out of view); *C*, main clock movement, going and striking trains; *D*, lunar and tidal train; *E*, orrery mechanism; *F*, annual train, driving the orrery; *G*, mean time dial; *H*, astronomical dial; *I*, heathen deities mechanism (chariots); *J*, chief cities dial mechanism; *K*, cycle of sun mechanism; *L*, solar time mechanism; *M*, cycle of the moon; *N*, cock mechanism; *O*, going train-weight; *P*, striking train-weight; *R*, main driving shaft.



The principal parts of the mechanism of Mr. Smith's model of the Strasburg clock.

XIV, each in their time patrons of the arts. On the front of the weight tower are paintings of Urania, the Muse of Astronomy; Nicholas Copernicus, the famous astronomer; J. B. Schnilgue, the maker of the reconstructed Strasburg clock; three fates spinning, measuring and cutting the thread of life. A spiral staircase in the original leads to the mechanism in the central tower and to the church tower. In 1890, at the instigation of the Hon. Bruce Smith and Sir William McMillan, the New South Wales government decided to purchase Mr. Smith's model and appointed the Hon Bruce Smith, Q. C., minister for public works, and the Hon. J. H. Carruthers, minister for education, to make the purchase for the Sydney Technological Museum.

KAEMPER'S DISCOVERIES IN THE MAMMOTH CAVE.

(*Concluded from page 388.*)

Should the occasion arise for selling the Mammoth Cave estate, it would be to the advantage of the owners to possess this complete and exclusive survey made by Mr. Kaemper at their own expense. The fact that such a survey has been made is of interest to men of science. But by far the larger part of it will never be seen by any except "cave cranks"; and even now the average visitor sees only about the tenth part of what is found on the guide map.

Yet it ought to interest the general public that the new survey covers about fifty miles more than the hundred previously mapped; and that, not counting mere enlargements, there are now known and located 69 pits and 39 domes, or in all 120 vertical shafts, 35 of which are newly discovered. As yet few of them have been named. Mammoth Cave is really a congeries of hundreds of caves joined into one vast cavern by the breaking down of walls and floors through at least five distinct levels or tiers. This fact is only partly indicated on the standard guide map; but in the new survey the levels are shown by proper shading or colors. As an example, the combination known as Ganter Avenue, and which was accurately surveyed by myself some years ago, includes Black Snake Avenue, Indian Avenue, Welcome Avenue, etc., making a total of 8,500 feet of passageway from the Wooden Bowl Room to Serpent Hall. But to show all this on a portable map would make it unwieldy. Instead of attempting bulky details, let us limit ourselves to the description of the lately found "Violet City."

When Dr. R. E. Call and myself were preparing our manual in 1897, we were anxious to work a passage through a certain "tumbledown" in the Main Cave; but failing to do so, we named the spot "Ultima Thule." A massive wall of limestone blocks closed the avenue entirely, with the exception of an extremely narrow "crawlway," which we had found impracticable. Kaemper and Bishop attacked this crevice again, and at the risk of their lives. A broad slab pinned down Kaemper's neck to the floor, and another his back. With difficulty he extricated himself. But while there he heard the sound of falling water, which proved to him that the Main Cave continued beyond.

Nearly a month later, on the singular theory that there must be a connection between Ultima Thule and Sandstone Avenue at the end of the Long Route, where there is also a waterfall and a tumbledown, the explorers tried to force their way through from the latter, but in vain. Then they renewed their attack on Ultima Thule. By patiently removing many fragments of rock, they finally succeeded in worming their way through—not as was expected into Sandstone Avenue, but into a great oval hall 160 feet long, 120 wide, and 60 high, which now bears the appropriate name of "Kaemper's Hall." On the left they found a pit 90 feet deep, to which the name of "Bishop's Pit" has been given, in honor of the guide. Down into this profound abyss dashes the waterfall the music of which had led them on. Fifty steps to the right brought them to a short passage opening into a second hall, 75 feet in diameter and of about equal height, vaulted by symmetrical arches closing in a beautiful circle above. This they named "Elizabeth's Dome," for Mr. Kaemper's sister. On the left are several pits, making with others eleven pits in this general locality. One of them is named the Parrish Pit, for the cave explorer, Mr. Norman A. Parrish, of Buffalo, N. Y.; and the rest are as yet unnamed. It is supposed that they all open into an unexplored hall below. In the short avenue leading into Elizabeth's Dome, an iron gate is now fixed as a protection against spoliation of the brilliant formations beyond. The exit from the dome is by the Grand Portal, an arch 60 feet high by 50 wide, commanding one of the most impressive views in the underground world.

A steep hill of loose rocks forms the natural dividing line between two immense chambers. When I was there, last November, my companions, Kaemper and Bishop, requested me to seat myself at the top of a flight of steps, while they went forward, Bishop carrying an automobile searchlight brought in for the purpose, thus giving me my first view of the wonderful and fascinating region to which has been given the name of "Violet City," in honor of Mrs. Violet Blair Janin, the fair owner of two-thirds of the Mammoth Cave estate, whereof her husband, Judge Janin, is the principal trustee. The central portion of the so-called "city" is a massive formation named "Blair Castle," from its striking resemblance to a castle on the crest of a hill. The environs are styled "Walhalla," for the fabled realm above the clouds where dwell the heroes and gods of old German mythology.

Picking up our torches again, and carrying my bicycle acetylene lamp (to which a convenient handle had been affixed), we followed a natural pathway near the wall on the left that led us from place to place in Violet City. We found it an immense expanse, measuring by the tape line 250 feet in length and 125 feet in width, with an estimated height of about 100 feet—dimensions rivaled only by Wright's Rotunda and the Chief City. A great cave-in of sandstone rocks closes the end of the chamber, which seems to indicate the proximity to the Sandstone Avenue, or a similar locality. These rocks are cemented together by a wonderful profusion of onyx.

Stalactites and stalagmites abound throughout the Violet City, varying in color from the purest white alabaster through every imaginable shade. The upper central part of the hill is crowned by three masses of fluted white onyx, glistening with exquisite crystals, while from the roof hang in fine array stalactites eight or ten feet long. The right wall is decorated with pure white formations, and the left wall is coated with brown onyx. A row of beautiful stalactites of varying length emit musical notes when struck by the staff or the knuckles, and by skillful percussion simple airs can be played. Other attractions excite surprise. "The Beer Mug," a small stalagmite resembling a mug of foaming ale; the "Ripe Tomato," a rare bit of red onyx, and other odd specimens of natural mimicry are among these. One familiar with the brilliant formations found in the wonderful caverns of Luray might easily imagine himself in that Virginian fairyland, instead of in the Mammoth Cave of Kentucky. Thus far these marvelous treasures have been untouched by vandal fingers, such as have robbed or destroyed elsewhere what should have been most jealously guarded in the greatest cavern in the world.

In his zeal to open a passage from Violet City to the Sandstone Avenue, Mr. Kaemper obtained permission to use explosives, by means of which he made considerable progress. But indications appeared that he was likely to burst through to the surface, instead of into the Sandstone Avenue, and accordingly he desisted. In either event the result might have been of advantage. An opening into Sandstone Avenue would enable visitors to make the circuit through the Main Cave to the Maelstrom, and return by the Long Route without having to retrace their steps. And an opening to the surface would enable them to return by coach to the cave hotel, thus saving a tiresome tramp underground. To prove the proximity of the places mentioned, Kaemper and Bishop repaired, the one to Violet City and the other to Sandstone Avenue, agreeing on a fixed moment by the watch when they would fire revolvers, and likewise hammer on the rocks. The pistol shots were not audible; but the blows on the walls were faintly heard. By similar sound-tests it was determined that Wright's Rotunda is directly over the Serpent Hall, so that it would be possible to connect them by a stairway through a shaft. Incidentally, I may say that while we stood in the Chief City, we plainly heard the steam cars running overhead along the Mammoth Cave railroad.

It will be good news to all persons who have ever visited the Chief City and region beyond it, that a comfortable path has lately been cleared by removing the myriads of teetering slabs, over which so many have hitherto toiled slowly and in peril of sprained ankles or broken bones. It will also interest the public to know that, instead of the two long-established exhibition routes, four are now marked out for showing the most accessible and attractive features of the cavern. Three routes are shown in the accompanying sketches; while the fourth and longest one, to the Maelstrom and Hovey's Cathedral, follows lines indicated on the general guide map.

The facts now offered indicate that substantial progress has been made toward the solution of some of the mysteries of the greatest of all known caverns. Although the long-delayed instrumental survey is at present only in the hands of the trustees, it is sure to be an important factor when the cave is offered for sale; as it shortly must be, according to the terms of the will of the late Dr. John Croghan.

A happy suggestion has been made that, whenever the proper time arrives, this noble estate, and a number of adjacent caverns, along with the primeval forest by which they are yet environed, and including some of the mighty cliffs that flank Green River, should be reserved, either by the State of Kentucky or by the United States, and be known as the Mammoth Cave Park.

The Scientific American Fourth Dimension Contest, which closed April 1st, will be decided in June or July.

FEEDING THE AMERICAN ARMY.

BY B. B. WINSLOW.

Every great general who has maneuvered a large fighting force has discovered the truth of Napoleon's declaration that "an army travels on its stomach"; and to more than one has come the bitter realization that the best army is the army that has the best stomach. There is nothing which so completely withers patriotism and smothers courage as the gnawing pain of indigestion; therefore, the feeding of an army has been given as much study as its equipment as a destroying force.

In the superiority of food, based on the cost of the ration, the American army stands far ahead of the other armies of the world; in fact, there is no comparison whatever between the American ration and that of any other country on the globe. The cost of the American army ration is nearly one hundred per cent greater than the British army ration, and none of the other countries with big military establishments feeds its soldiers anywhere nearly as expensively as the English government does.

The American army ration is divided into three kinds: Garrison ration, field ration, and emergency ration. The garrison ration is that given soldiers at regularly established military posts; field ration, that issued to troops in the field in active campaign. The emergency ration is a condensed ration, in which the best and most valuable nutritive elements are combined in the smallest bulk. In composition the garrison and field ration are almost identical. Each ration, which is supposed to keep the soldier one day, furnishing breakfast, dinner, and supper, consists of 20 ounces of fresh beef or mutton, 12 ounces of bacon, 16 ounces of canned meat or canned fish, 14 ounces of dried fish or 18 ounces of pickled fish, 18 ounces of flour or 20 ounces of cornmeal, either 2 2/5 ounces of beans or peas or 1 3/5 ounces of rice or hominy, and either 16 ounces of potatoes or 12 4/5 ounces of potatoes together with 1 3/5 ounces of either onions or tomatoes, 1 3/5 ounces of dried fruit, 1 3/5 ounces of coffee, and 3 1/5 ounces of sugar. The ration also includes very small quantities of vinegar, salt, pepper, soap, and candles.

Nowhere except in the army can the food supply of 30,000 men be managed by 120 men. This can be done with the army on the march, changing station every day. The unit of administration is the corps, supposed to consist of 30,000 men. The unit of actual accountability, however, is the brigade. Ordinarily, an army corps will consist of three divisions, and each division will have three brigades. The chief commissary of the division issues his stores to each brigade in bulk. The brigade commissary in turn issues to each regimental commissary, also in bulk, and the regimental commissary issues to the companies. The rations are usually computed by the hundred, and are issued for ten days. A company of one hundred men would, therefore, be issued one thousand rations. In the field each soldier is supposed to carry one regular ration and one emergency ration all the time. The emergency ration is never eaten except in case of emergency, and the regular ration is issued every day.

The army ration, it will be seen, contains none of those things which are ordinarily considered luxuries. For instance, there is no milk included in the ration, and the soldier must take his coffee black unless he is able to purchase a can of condensed milk from the "sales store" with his "savings." Congress has authorized the commissary department to keep on hand other articles of food that are not included in the regular ration. These are kept in the "sales stores," and are issued to the mess steward in return for "savings" from the regular rations. Out of a company of a hundred men, there are a number who do not eat all of the articles in the ration. These would be wasted if drawn by the mess steward; therefore, when the thousand rations are issued to him, he returns to the commissary that part of the various components that he thinks will not be used. This, in the language of the army, is making a "saving" on the rations.

The value of the articles returned to the commissary is computed, and the mess steward is allowed to draw from the "sales stores" a sufficient quantity of luxuries that are not in the regular issue, equal to the value of his "saving." The government, however, will not allow a "saving" to be made on certain articles in the ration. Fresh meat, dried or preserved fish, potatoes, onions, tomatoes, prunes, apples, and peaches must be used; a "saving" cannot be made on these articles. They contain just the proper nutritive elements, and the quantities given are what the normal soldier should eat.

The company fund is another way in which the ration may be improved, especially at regular army posts. There are many sources of revenue for the company where there is plenty of ground at the post. Many of the companies have vegetable gardens, and keep pigs and cows. The pigs are fattened on the leavings from the kitchen, making their feed cost nothing. They are fattened and sold, the money go-

ing to the company fund, or they are killed and the meat turned over to the mess. Where cows are kept, a good sum is derived from the sale of milk to the officers at the post. This money, which all goes into the company fund, is used to buy the luxuries not obtained in the regular issue—to "improve the issue," as it is termed.

In the field, in maneuvers or in actual warfare, it is difficult, and sometimes impossible, to keep the cooking outfit with the company. The rations are then issued to the men individually, and they are left to their own devices as to the methods of preparing them for meals. Each soldier has a mess kit, consisting of two tin plates that fasten together, a knife and fork, and a tin cup holding a quart. While this kit is welcomed as a means of preparing his food, the trooper finds it an additional burden, not only in the extra weight, but in the labor that must be expended in keeping the outfit clean, for they must be kept bright.

At the post these hardships are removed. The soldiers' meals are cooked by the company cook, who draws the pay of a non-commissioned officer. Everything is in the hands of the mess steward, who is assisted in his work by a dining-room orderly, a private, and the kitchen police. The kitchen police is a detail of two or three privates for duty about the kitchen. The dining-room orderly has charge of the dining room, and cares for the dishes after they have been cleaned; he keeps the pantry in order, and sets the table. All of the mess force, from the steward to the kitchen police, are excused from guard and ordinary duty.

The Current Supplement.

The necessity of lightning protection arises from the consideration of the loss which might ensue from damage by lightning to buildings and other structures. This necessity has found expression in lightning arresters. In the current SUPPLEMENT, No. 1742, the fundamental principles of lightning arresters are ably discussed by David B. Rushmore in an article entitled "Recent Developments in Lightning Arresters." F. E. Drake describes "The First American Steam Turbine," which was none other than the "Bailey Jack." "Little Things in the Shop that Save Time, Money, and Labor" is the title of an article which describes some amateur mechanical appliances. Herbert Chatley contributes an interesting article on the "Difficulties in the Construction of Aeroplanes." For a number of years the German Orient Society has uninterruptedly carried on systematic excavations in two of the most important centers of the ancient Babylonian-Assyrian civilization. This work is interestingly explained, and the results summarized by Prof. Morris Jastrow. Prof. Edgar L. Larkin gives a clear description of what is known as "Doppler's Principle" in astronomy. In an article by O. Bechstein the subject of "Artificial Drying of Agricultural Products and Wastes and Its Economical Importance" is ably handled. Guenther Schmid traces the relation of chlorophyl to light.

Artificial Nitrogenous Fertilizers.

The infant industries of manufacturing cyanamide and nitrates by electrical processes are threatening to destroy each other by mutual competition. A French writer has conceived the idea of a hydro-electric establishment capable of producing simultaneously calcium nitrate, cyanamide, and ammonium sulphate. In Frank's cyanamide process, the nitrogen of the air is utilized and the oxygen is wasted. In the Birkeland-Eyde process of producing nitrates, on the contrary, it is very advantageous to direct upon the electric arc a current of air containing an abnormally large proportion of oxygen. Again, Sir William Ramsay has recently published experiments which indicate that the production of ammonia by direct combination of nitrogen and hydrogen may soon become commercially possible. The proposed factory, therefore, would include electric furnaces, apparatus for producing nitrogen and oxygen by means of liquid air, and apparatus for the electrolysis of water. The three gases, oxygen, nitrogen, and hydrogen, thus produced would be utilized as follows:

The oxygen would be mixed with the air blown into the Birkeland-Eyde electric furnaces for the production of nitrates, part of the nitrogen would go to form cyanamide with calcium carbide, and the rest of the nitrogen would be combined with the hydrogen to form ammonia, which could easily be converted into the commercially available ammonium sulphate.

The number of boiler explosions in the United States in 1908 was 470. This compares with 471 in 1907, 431 in 1906, 450 in 1905, and 391 in 1904. The number of persons killed by boiler explosions in 1908 was 281, against 300 in 1907, 235 in 1906, 383 in 1905, and 220 in 1904. The number of persons injured, not fatally, in 1908 was 531, against 420 in 1907, 467 in 1906, 585 in 1905, and 394 in 1904. The record of boiler explosions in the United States for 41 years and three months, since October 1st, 1867, shows a total of 10,051, in which 10,884 persons were killed, 15,634 injured.

Correspondence.

MAN'S GENEALOGICAL TREE.

To the Editor of the SCIENTIFIC AMERICAN:

Few people realize the innumerable number of links which bind each one of us with our forefathers. Starting from the fact that we each have four grandparents, eight great-grandparents, sixteen great-great-grandparents, and so on, ten generations back, or a little more than three hundred years, there were 1,024 direct progenitors of each family living. Twenty generations would give over a million; and thirty generations, or about one thousand years, say from the date of the death of Alfred the Great, increases the total to the amazing figure of more than 1,094 millions.

That is to say that each family represented on earth to-day had, thirty generations back, 1,094 millions of progenitors living at that time, that is contemporaries, or of the same generation; or about two-thirds of the total number of the computed inhabitants of the whole world to-day, which is estimated at about 1,500 millions.

The thirty-first generation would give 2,198 millions, and soon, doubling with each generation until a few generations further back, long before the 5,000 to 6,000 years of authentic history is reached, which after all is but a mere fraction of the time that man has lived upon the earth, would yield a number for which there would not be standing room upon the globe; and this for *one family only*.

Some would have to be canceled as being progenitors of more than one line of descent—ancestral duplicates, as they may be called; but this would not account for many, I imagine, unless people are very much more closely related by blood than is generally considered.

On second thought, however, it may be that herein lies the solution of the difficulty. If so, it would prove that mankind are truly brethren—much more closely inbred, in a sense much more real than has been supposed.

It should seem to be not an unreasonable assumption, in view of the figures given above, that the farther back we go, the more fully was the earth peopled, instead of the reverse.

And yet historical writers—Fisher, for instance—put the total population of England under the Tudors at less than two millions.

Can any of your readers throw any light upon this subject, or show where I have gone wrong in stating the problem, which fairly puzzles me?

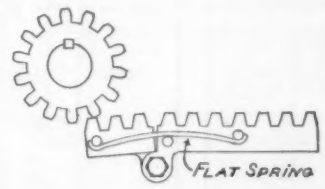
New York. A. K. VENNING.

A RACK AND PINION PROBLEM.

To the Editor of the SCIENTIFIC AMERICAN:

On page 279, issue of April 10th, 1909, Constantine Shuman asks the readers of the SCIENTIFIC AMERICAN to send in their solutions of his problem in mechanics.

I have found this problem very interesting, and have worked out a solution that I think will fill all the



requirements. In my solution I have the three teeth on the end of the rack hinged, so that if the top of one of the teeth on the gear wheel should happen to come in contact with the outer edge of the tooth on the end of the rack, instead of jamming the teeth the hinged part will swing downward, allowing the next tooth to engage with the rack. HERBERT STARR.

Malden, Mass.

SULPHATE OF COPPER AS A FUNGICIDE.

To the Editor of the SCIENTIFIC AMERICAN:

I notice in a recent number of the SCIENTIFIC AMERICAN a short article which says that the German government has failed in treating telegraph poles with sulphate of copper, and it seems they have abandoned that chemical as a fungicide.

This article leaves the reader under the false impression that sulphate of copper is not a good fungicide. The facts are this chemical stands second in the long list of germicides as to its effectiveness when used properly.

See volume i, p. 74, "Bacteriology," by I. F. Smith, published by the Carnegie Institution of Washington in 1905.

The writer treated telegraph and telephone poles over nine years ago with sulphate of copper. These poles were rotted in from one to two inches at the ground line. The decay was entirely stopped and the poles now are as good as when treated, and are still in use.

By our method, we dig around the pole at the ground line; and place a jacket around the same extending below the surface about sixteen inches. The space between the pole and the jacket is filled with a mixture of sulphate of copper or any of the well-known fungicides, with sand.

A reinforced cement is formed over the top. The natural moisture of the pole dissolves the chemicals slowly, and they are absorbed by the pole, and thus the delicate little fungus is killed.

These wood-destroying germs begin their ravages on the outside, and not from the inside of the pole. Hence by this method there is no need of deep penetration.

The difficult problem has always been to prevent outside germs from entering after those on the surface of the pole are killed. This the asbestos jacket accomplishes, and in addition prevents the strength of the chemicals from being wasted in the surrounding soil.

Canalboat builders on the Ohio Canal have been for years in the habit of placing dry salt between the ribs of their boats. It was taken up into the pores of the timber by capillary attraction and osmotic force, thus poisoning the food of the fungus. Most metal salts and the light coal-tar products have been discarded by pole preservers when the brush open and closed tank methods have been used. This was not because they were not good germicides, but because they would leach out into the surrounding soil as soon as placed in the ground.

The trouble with sulphate of copper is not that it is not a good fungicide, but it is too soluble when used by the brush or tank methods. One drop of a solution of sulphate of copper will kill all the algæ in a fish aquarium holding four gallons of water.

Circleville, Ohio. H. P. FOLSOM.

THE "NORTH DAKOTA'S" TURBINES.

To the Editor of the SCIENTIFIC AMERICAN:

In the unsigned article on the "North Dakota's" turbines in your issue of April 17th, the statement is made that in the Curtis type of turbine there is no tendency for leakage around the outside of the blades, and a comparison is made with the Parsons type, rather deprecating the latter. Leakage around the blading of any turbine is caused by a difference of pressure between the opposite sides of a given row of buckets, is it not? In the Curtis, a type of impulse turbine, the steam being expanded gradually throughout its entire course through the machine, it seems to me that there must be a difference in pressure between any two points in its course of travel, and hence a tendency for leakage. On the other hand, I have heard the same claims made for the Parsons type that this writer makes for the Curtis, i. e., the possibility of large clearances without leakage. Theoretically, the only way to prevent the tendency to leakage around the blades would be to expand the steam before striking the blades, as in the Rateau or De Laval, when there could be no difference in pressure on opposite sides of a bucket wheel, the action being due there to velocity alone. I know from my own observation that the smaller sizes of Curtis turbines are built with very small clearances, as low as 0.01 inch in some cases between rotor and stator.

In view of the unofficial reports of the coal and water consumption of the three new test scout cruisers as published, for instance, in Power for April 13th, where the Curtis turbine shows up rather poorly, are the commendatory remarks of your article referring to this type of turbine altogether justified?

I trust you will not think my remarks impertinent. I am not an engineer—yet; but only a young man seeking information and a zealous reader of your paper.

CHARLES H. ROE, U. S. N.

U. S. S. "New Hampshire," Guantanamo, Cuba.

[In the Curtis type the steam is expanded in a set of nozzles before it impinges on each set of blades, and its tendency is to pass across the face of the blades in a general direction parallel with the axis of the turbine. In the later turbines the clearance between blades and casing is large. In the Parsons type the expansion takes place within the turbine, and therefore the end clearances must be as small as possible. We shall publish the official reports of all trials as soon as they are available.—ED.]

Marble Deposits in California.

The principal deposits of marble in the United States are in Vermont, Georgia, Tennessee, and California. Extensive quarries are worked in Inyo County, California, and the existence of large bodies of marble in the desert of San Bernardino County has been known for some years; but until recently the deposits have remained untouched except at Colton, where marble is quarried in small quantities. At Cadiz, a station on the Santa Fé Railway, 240 miles to the east of Los Angeles, many varieties of marble of fine quality are found. Marble of twenty or more various colors is found in large quantity and there are smaller deposits of marble of many colors, ranging from black to pure white, with red, blue of several tints, Persian gray, and numerous other hues. The deposits also yield a beautiful black marble with figures of sea shells, named shell marble, and a black with lines of gold which is said to be found in no other region except on the banks of the river Nile. The deposits have been examined by Prof. Stephen Bowers, a geologist, and by a Tennessee quarryman, who declare that the marble is easily worked; being strong, it can be taken out in blocks of any size, sawed, and polished. Six miles from Cadiz and two miles to the west of Black Mountain is a great deposit of white marble, between 400 and 500 feet in height. The nearest point of the Cadiz quarries is only one mile, and the farthest is not more than six miles from the railroad. The country being level, the haul is an easy one. The great amount of building now going on in San Francisco, Los Angeles, and other Californian cities assures a good market for marble of high quality, which hitherto has had to be brought from the Eastern States, or from Italy, Belgium, Africa, or China.

The strength and flexibility of cotton yarn, used for weaving, can be increased by applying a dressing prepared as follows: 25 parts of white Java wax, 20 parts of cottonseed oil and 15 parts of Australian tallow are first saponified in such a manner as to produce 100 parts of soap. 30 parts of glucose, 15 parts of soda, 10 parts of manioc flour, 5 parts of zinc chloride, and 40 parts of water are mixed without heating. Equal parts of this solution and the soap are heated together, with continual stirring, to 176 deg. F. for two hours, and the mixture is then allowed to cool, the stirrer being kept in operation.

COL. J. J. ASTOR'S VIBRATORY DISINTEGRATOR.

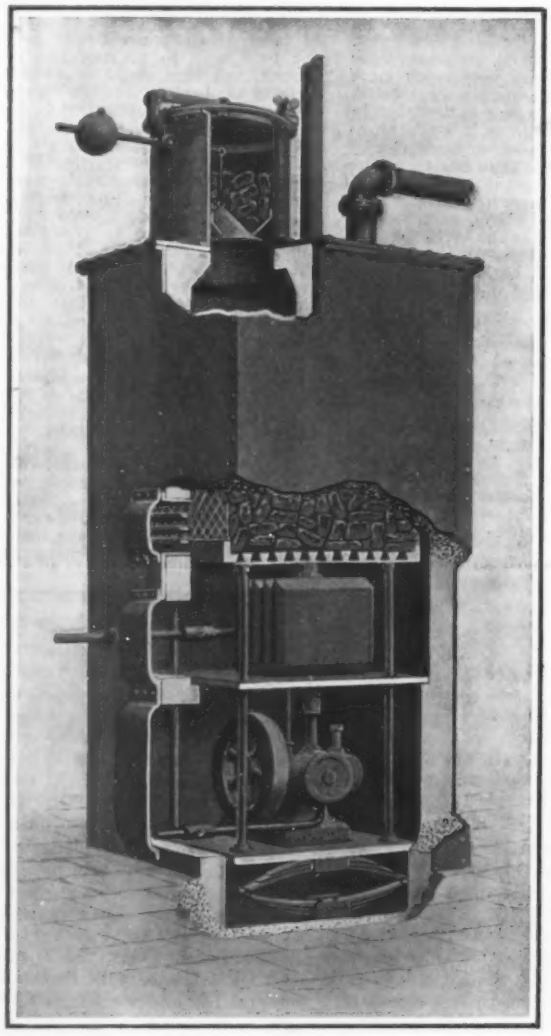
AN INGENIOUS DEVICE WHICH MANUFACTURES PRODUCER GAS FROM PEAT AND THE PATENT COVERING WHICH WILL BE GIVEN TO THE PUBLIC.

Col. John Jacob Astor of New York city has appeared more than once as an inventor of practical and useful devices on the Patent Office records. He has devised and patented in past years an ingenious bicycle brake, a novel pneumatic road improver, and an efficient marine turbine, the patent covering which last invention he gave to the public. Col. Astor's latest invention is a means for practically and successfully utilizing as a fuel for power the vast deposits of peat found in this country and in other parts of the world.

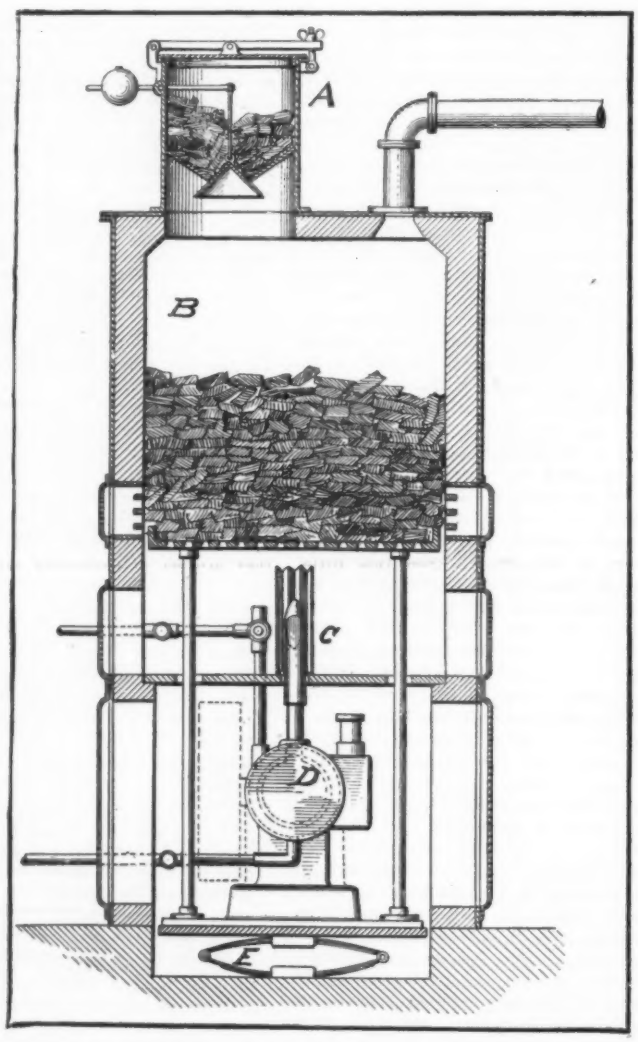
The economic utilization of the enormous peat bogs found throughout the temperate zone has been a problem baffling scientists and engineers for a great many years. Attempts at reclaiming the peat bogs to make arable farm land have met with partial success in Norway and Sweden. Peat has been successfully used as a fuel, but due to the large amount of water contained in the peat, it is necessary to dry it for a long time before it can be burned.

Peat constitutes a fairly serviceable fertilizer; but due to the large amount of tannin, organic acids, iron salts, and gases contained in the peat, it is necessary to cure it by long exposure to the atmosphere before it can be applied to the soil. The tannin and organic acids in the green peat act to kill and retard vegetable life rather than support it.

In Sweden attempts have been made to manufacture producer gas from peat, but these attempts have met with poor results, while the experiments made in this country have been unsuccessful. Inasmuch as the peat contains a considerable quantity of water and the solid portions are almost entirely carbonaceous, it is better adapted in some respects for the manufacture of producer gas than is bituminous coal. Ordinary peat is of a very porous and loose texture, and a great deal of gas is occluded among its fibers. It has such poor heat-conducting qualities that, when heated in a producer, a portion of the peat will be completely burned without heating other portions to any material extent.



Perspective view of Col. Astor's peat gas producer.



Sectional view of Col. Astor's peat gas producer.

A NEW INVENTION OF COL. ASTOR'S, WHICH THE PUBLIC WILL ACQUIRE BY GIFT.

The vibratory disintegrator which has been invented by Col. Astor and which, it is believed, will solve the problem of the commercial manufacture of producer gas from peat, utilizes the expansive force of the air and gases within the very porous peat to disrupt and disintegrate the latter, and to permit the peat to be thoroughly and uniformly heated. The gas generated may be supplied to an ordinary internal-combustion engine *D*, the engine muffler *C* being placed inside the gas producer. The sides of this muffler are thin, so as to permit them to be distended and drawn inwardly upon variations in the pressure within the muffler. The edges of the muffler may be fluted, corrugated, or accordion plaited, to facilitate this relative movement of the opposite sides, and one end of the muffler is connected to the exhaust pipe. The gas escaping from the engine cylinder after each explosion in the latter tends to expand the muffler, and as the exhaust gas escapes from the muffler, the sides will again contract. These vibrations of the side walls of the muffler cause the successive compression and expansion of the gas within the gas producer, and likewise the gas included in the pores and interstices of the peat. As a result, the cells and pores contained in the peat are disrupted, and the peat is broken up and disintegrated.

To further aid in breaking up and disintegrating the peat and permitting of its uniform heating, the peat chamber *B* of the producer is supported from the engine frame or base *E*, so that the jarring and vibrating of the engine frame is transmitted to the peat.

Any suitable form of gas engine may be employed, but preferably one running at comparatively slow speed, so that the successive charges of exhaust gas will have time to produce the desired expansion in the muffler. Preferably, an air-cooled engine is employed, and the air utilized in cooling the engine cylinder is delivered in part or in whole to the base of the producer.

Inasmuch as peat can be obtained by the farmers in many sections of this country for the mere trouble of digging the same, it is evident that producer gas could be manufactured at a very low cost. This would permit the farmers to drive various kinds of farm machinery by gas engines, to illuminate and heat their homes, and give them a very valuable fertilizer for their impoverished soil as a by-product in the peat residue.

Col. Astor is now erecting a peat-fuel producer-gas plant at his country place at Rhinecliff on the Hudson, in which the vibratory disintegrator will be given a practical test. The plant, of about 150 horse-power, is to run a stone crusher; and if the peat yields its gas, as it is confidently believed it will, it will mean an engineering advance that may have very far-reaching results.

The patent application is now pending, and on its being allowed, Col. Astor intends to present it to the public, in the hope that it may be of wide general use.

The Museum of Safety and Sanitation has announced that the United States Steel Corporation has organized a safety committee, consisting of twenty experts, whose business will be to examine their various plants, with a view to making suggestions for safeguarding machines or processes. Last year, according to their reports, the corporation spent $55,000 in following the recommendations of this committee.

Production of Artificial Pearls by the Oyster.

The earliest theory of the production of pearls was that they are congealed dewdrops, though no explanation was given of the manner in which the dew got into the shells of the oyster. Another early notion was that pearls are the eggs of the oyster; the difficulty connected with this view being the extreme paucity of pearl-bearing shells. The Chinese were the first to solve the problem and to find out that pearls are due to the irritation produced by the introduction of a particle of foreign matter, such as a grain of sand, into the shell of the oyster. This bit of irritating matter is coated by the oyster with nacre like that with which the shell is lined and the result is a pearl. The artificial production of pearls in this manner is carried on by the Chinese and Japanese to a considerable extent. The shells of the bivalve are separated gently and a small bit of mud or a tiny piece of lead is inserted under the flesh to serve as a nucleus for the pearl. The shells are then allowed to close and the oysters are placed carefully in a stream of water and fed on manure. After a proper interval the shells are opened and the nuclei, now coated with nacre, are removed. The nucleus is generally taken out and the cavity filled up with wax. In one of the provinces of Japan a large area at the bottom of the sea is devoted to the artificial production of pearls by oysters, four years being allowed for the process. Though the pearls produced in this way are not as fine as those found naturally in the oyster, they still possess beauty enough to be salable. The artificially produced pearls are not so beautiful nor so well-shaped as the natural ones, and their underside generally lacks luster entirely. Though this makes them unsuitable for necklaces, they can be used in other articles of personal ornament, where the whole pearl is not seen. Such pearls can hardly be termed "artificial," for they are genuine, though the method of production is not wholly natural. Yet, though the process is started artificially, it is carried on in a strictly normal, natural manner. So it is hard to find a quite exact name for the product.

A Novel Expansion Bolt.

Expansion bolts are made in many styles and sizes. They are used whenever an object is to be fastened to brick, stone, marble, concrete, tile, or slate. They are made in every conceivable size—from ⅛ inch to 2 inches in diameter—for use with wood screws, machine screws, lag screws, and machine bolts. A rather novel expansion screw recently introduced consists of two parts—one an ordinary screw proper, and the other an expansion sleeve of lead composition. After the hole is drilled, the expansion sleeve is inserted and the screw thrust into the sleeve. As the screw is turned in with the screwdriver, the inner end of the expansion sleeve expands, and buries itself firmly into the material.

A similar principle is adopted in a two-piece lag screw, which is used in large quantities by the government. This particular lag screw is designed for use with all coach or lag screws from 5/32 inch to 1/32 inch in diameter.

THE SIGAFOOS TUNNEL MACHINE.

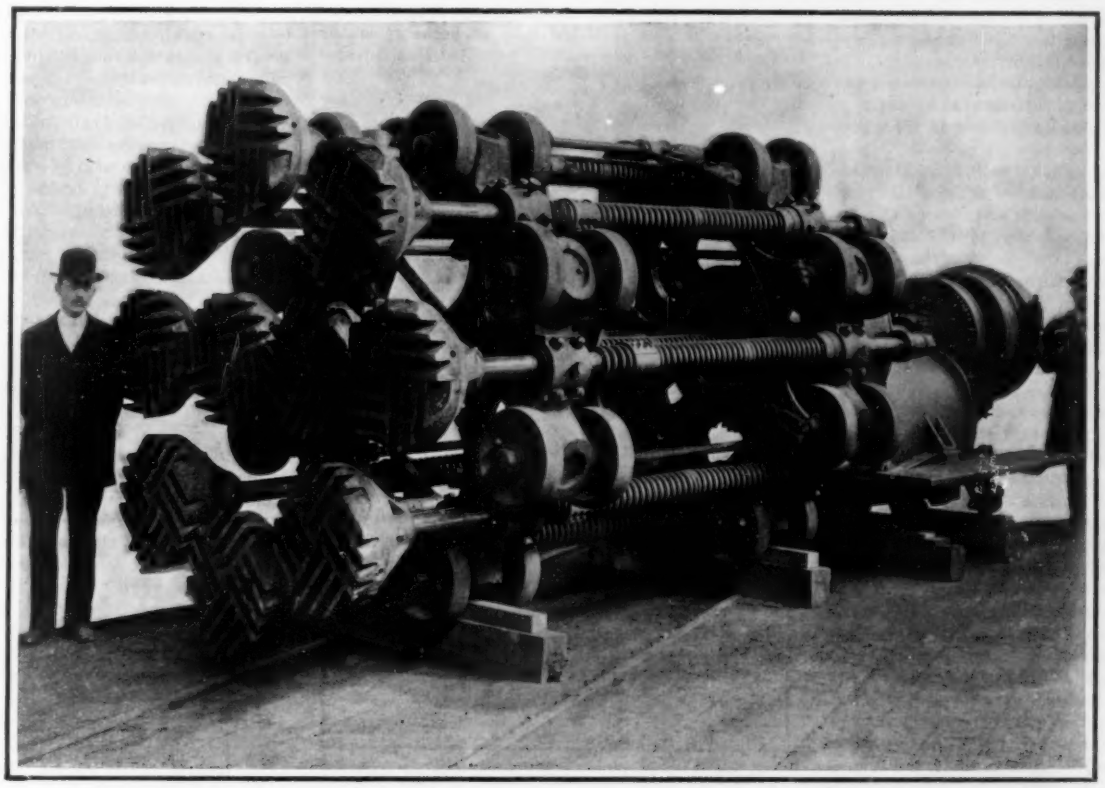
BY ROWLAND ASHFORD PHILLIPS.

Like the poor, new ideas for tunneling through rock and doing away with drilling and powder and dangerous blasting, are forever with us. Since 1853 there have been no less than sixty-nine patents granted on tunneling machines, and of this number but three have progressed beyond the blue-print stage. One was constructed and used with some slight success in the East, but owing to lack of funds or disputes among its builders, all progress was stopped. The second was built in Colorado, and at the present time is installed in a tunnel near Boulder. This machine does the work claimed for it, but the cutting is very irregular, numerous breakdowns are constantly happening, and in the course of over six months the machine has penetrated but a few hundred feet.

The third machine, here illustrated, was invented by Mr. Sigafoos, of Denver, long associated with many eastern manufacturers until of late, when he turned his mind and labor toward western mining fields. Mr. Sigafoos built his first model three years ago, and until the present day it is on exhibition in his offices. Even this little working model, barely two feet long, has eaten through solid granite quite as easily and determinedly as a hungry earthworm.

Early in January of this year the first regular-sized machine was constructed in the East and shipped complete to Georgetown, Col., where the first contract was let and its behavior eagerly watched. The utmost secrecy was observed for the first trial, and the author was extremely fortunate in being allowed to witness the test. In every instance the rotary proved its value, and came up to the highest expectations. Mr. Sigafoos stands ready to take contracts with his machine, in any and all rock, and will guarantee to cut five feet an hour, twenty-four hours a day.

The machine complete, ready for work, weighs 29 tons, and its length is slightly in excess of 18 feet. This huge frame holds ten crushing heads, as the photograph shows, each carried on a 4-inch horizontal shaft and working on the same principle as a stamp mill, with the exception that the blows are given with the aid of springs instead of force of gravity. The entire fore part of the machine revolves as it cuts, thus cutting a full, clean bore, all the muck being flushed from the tunnel by means of a 3-inch stream of water, carried directly through the machine under 40 pounds pressure, and fed through ten small nozzles, each of which sends a stream beside each crushing head. This constant revolution of the machine is its strong point, the body being run on a series of "foot" wheels, thirty-two in all. The axles of these wheels—they are set in pairs—are arranged so they may be set at will, preventing the wheels from tracking. A simple twist sets them at an angle, and thus the whole machine moves forward or backward not unlike a huge screw.



Front end view of tunneling machine showing cutting heads.

The ends of the cutter shafts carry tappets, which, as they revolve, are acted upon by a 5-foot cam. This draws back the tappets and releases them. In relation to the hardness of the rock these blows can be regulated, and the drop varied from 4 to 12 inches by substituting other sized cams.

Of these monster crushing heads there are ten, eight on the outside of the revolving front and two in the center. The cam has a long, barrel-like hub, which permits the center shafts being brought back without interfering with the others. Diametrically opposite cutters strike at the same time. The springs which lend the force to the blows are 5 feet long, 6 inches in diameter, and composed of a specially chilled inch steel. These cutting or crushing heads, as they should be called—for the machine works on the principle of pulverizing the rock instead of cutting it—are 2 feet in diameter, the face of each being composed of a series of blunt teeth. These heads revolve about the axis of the machine as they strike, thus producing a grinding motion to the surface of the breast. In this one respect alone the rotary differs from all its competitors, and in doing so proves the wisdom of the method. Mr. Sigafoos has always maintained that a sharp or edged tool is worthless in tunnel work.

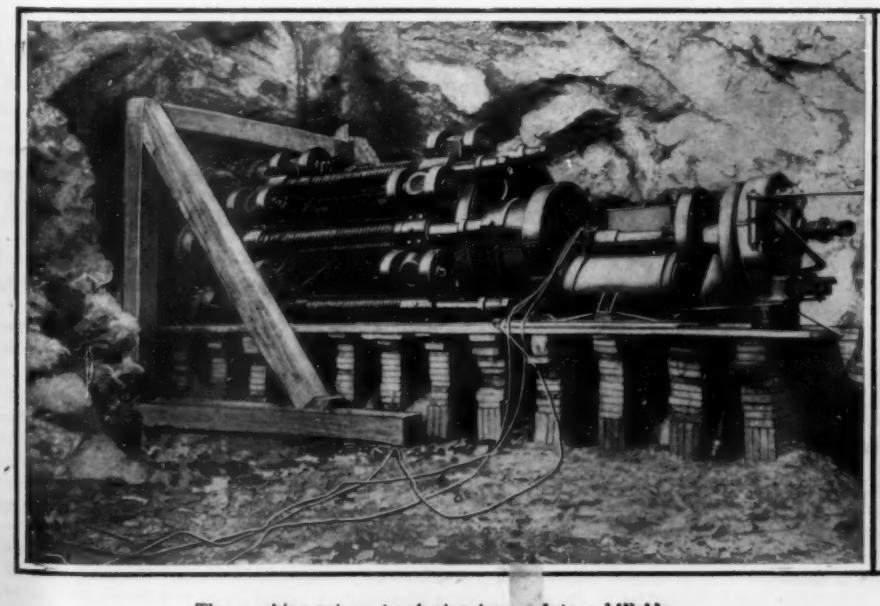
With an 8-inch drop these heads strike a blow of 4,000 pounds, two hundred times a minute. This means that a total of 8,000,000 pounds is expended against the breast of the tunnel every sixty seconds. It is claimed that if each head penetrates but the thickness of a sheet of common writing paper at a blow, it will cut in at the rate of an inch a minute.

In fact, the harder and more stubborn the rock, the more easily the machine will do the work; and it is doubtful if it would work at all in soft dirt or clay. The inventor purposely accepted this Georgetown contract because of the nature of the rock, it being long acknowledged the hardest in the State. The photograph, showing a 3-foot penetration, will in a measure give a good idea of the rock formation.

Should accidents occur, as they will in any machine, all that is necessary is to reverse the axles on the "feet" wheels, and the entire rotary will back itself out a sufficient distance to allow the men to climb through the framework—manholes are provided for this purpose—gain the space between the crushing heads and the tunnel breast, and set matters right. Here again the Sigafoos machine differs from the others, and is the only one in which the whole machine does not need to be backed completely out of the drift in order to replace or repair the parts.

The rotary is operated by a 150-horse-power motor, although one of 60 horse-power is sufficient to keep it running once it is in motion. This motor is mounted on the machine, on a sort of car, the engineer riding along with it, and controlling all movements with a single lever.

The time and money to be saved by this practical invention are inestimable. For it must be remembered



The machine set up to start a tunnel into a hillside.

Face of tunnel as punched out by the machine.

THE SIGAFOOS TUNNEL MACHINE.

that scarcely any timbering will be needed, as the machine cuts the walls as smoothly as dressed marble, instead of shattering them, as is done with powder. Then, too, all powder and fuse are done away with, and only a third as many men will be needed. And lastly, but one of extreme importance, the work is accomplished absolutely without the least danger.

A practical example may be interesting, and the inventor himself gives it. To run the ordinary tunnel, 4 by 7 feet, needs three shifts of about four men each. These men can, under ordinary conditions, cut about 12 feet in the twenty-four hours. Wages alone amount to over $65, while powder, fuse, and timbering will easily add as much expense again. Against this, the tunnel machine with three shifts of two men each can cut approximately 120 feet, at a total cost in wages of $24. There is absolutely no comparison in these two methods.

Tests have proved that light tunneling machines are impractical and worthless; and in spite of the fact that the Sigafoos machine weighs as much as any ten others put together, the inventor is increasing its weight. And in the face of this, other hopeful inventors talk of boring a tunnel with a machine of a few thousand pounds.

If, as will often be the case in boring a long tunnel, a "pay streak" is encountered, the muck washed out by the water can be run onto a large concentrating table at the mouth of the bore, a separation made then and there, and all values saved.

The machine is not limited in its work to starting into a hillside on virgin ground; it can easily be taken to pieces, carried any distance, and lowered into a shaft, to be at once set up in a drift ready for work.

At the present time, ten of these 8-foot machines are contracted for in the State of Colorado alone.

While this 8-foot machine will be sufficient for ordinary use in mining and in irrigation work, other contracts, for larger bores, such as railroad tunnels, will make it necessary to use a larger machine. This larger model is 8 feet longer than the former one, with thirty-six stamping heads instead of ten, and cutting a 12-foot bore.

It may not be amiss to state that the famous Moffat road will probably use these large rotaries in cutting its great tunnel through the mountains. In places to-day where the road ascends and descends mountains, it is expected within a short time to eventually bore through them, cutting down the time from coast to coast fully twenty-four hours. The contractors, before learning of the new machine, allowed ten years for the completion of this gigantic undertaking; but to-day, with a sufficient number of tunnel rotaries at work, two years will not be an impractical limit.

The immediate uses to which this machine can be put to work are innumerable. Subways that formerly took five years to construct can now be run for half the expense in one-tenth the time. Water in unlimited quantities can be brought through the mountain walls, and the vast arid areas of the deserts will be made to blossom as a wonderful garden.

If the claims made for it continue to be substantiated in practice, Mr. Sigafoos may well be considered a world's benefactor in giving us this marvelous rotary tunnel machine.

Dwellings in the United States.

At the First Census the marshal for the State of Massachusetts returned the number of dwellings in that State. It was not required by the federal government, nor was such a return made for any other State.

Upon tabulating the returns for Massachusetts, it appears that the average number of families to a dwelling was 1.2, and that the county averages varied but little. This fact, taken in connection with the prevalence of agriculture at that period and the practical non-existence of towns of large size, suggests the propriety of applying to the remainder of the country the average number of families to dwellings actually reported for Massachusetts. By so doing, 454,309 results as the total number of dwellings in the United States in 1790.

Analysis of the average number of persons per dwelling in Massachusetts reveals the interesting fact that the average was higher in 1790 than in 1900. The average at the later census is higher in the cities, doubtless due to apartment houses and tenements. The smaller general average in 1900, which is contrary to what might be expected, probably reflected the influence of the smaller size of family.

By a recent act of Congress the office of First Assistant Commissioner of Patents was created. Cornelius C. Billings of Brattleboro, Vt., who is now Assistant Commissioner of Patents, has been nominated for promotion to the new office, and Frederick A. Tennant of Ripley, N. Y., who is now an examiner in the Patent Office, has been nominated to take his place. The Senate has just confirmed the nominations, and on July 1st, when the new law goes into effect, the changes will be made.

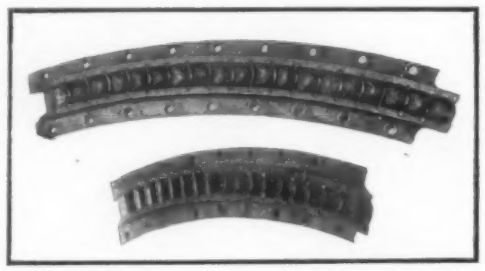
INJURY TO THE TURBINES OF THE SCOUT "SALEM."

The U. S. scout cruiser "Salem" has been sent to the builders, the Fore River Shipbuilding Company, for an examination of the main propelling turbines, which are of the Curtis marine type. During the recent competitive trials the starboard turbine, although there was no difficulty in its operation, ran considerably slower than the port, with the same steam supply, thus indicating that some internal derangement had occurred.

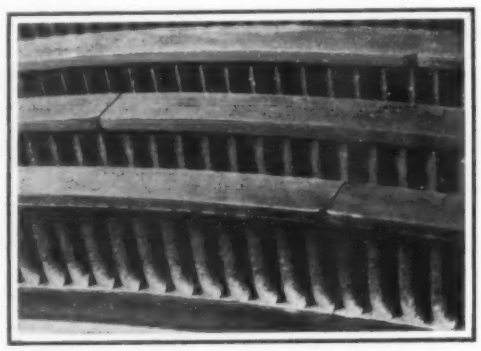
When it was opened, it was discovered that some foreign body had become caught in the fifth stage between the nozzles and first row of buckets; which had bent over the edges of the buckets so as to completely prevent any steam passing through them, and had broken about one-quarter of the nozzle division plates. The foreign body which caused this has not yet been found, but a loose ⅝-inch nut was found in the fifth stage, lying in the bottom of the casing, which did not, however, become caught in the moving parts.

Examination of the port turbine disclosed a service bolt, 2½ inches long, which was not a part of the machine, lying in the first stage against the nozzle openings leading to the second stage. The damage done here was comparatively slight.

The rotors of both machines were also found to have moved axially so as to allow the moving buckets to rub against the stationary guide blades, with the result that in the first and second stages, where the axial clearances are least, the guide blades were worn on the edges; but no blade stripping occurred. As in



Portions of turbine damaged by foreign body.



Buckets in the front row bent over by contact with obstruction, completely closing steam passages.

INJURIES TO THE BLADES OF THE "SALEM'S" TURBINES.

these stages the guide blades cover only a small part of the circumference, practically all the wear occurred on them and very little on the moving buckets. All blading was found to be entirely free from any erosion due to the action of the steam, and the surfaces were as smooth as when first installed.

This shows that the Curtis type of construction has a remarkable ability to withstand abuse and still remain in operative condition; as even in this condition the vessel made 24½ knots for twenty-four hours, and for the first eight hours made 25 knots, while the contract speed required 24 knots for four hours. Also the operation of the turbine was perfect, and except for the drop in revolutions, it would not have been known that any internal damage had occurred.

The damage is being repaired, and is expected to be finished in thirty days from the vessel's arrival at the yard.

Present Condition of the Norwegian Nitrate Industry.

The Birkeland-Eyde electric furnace, which is employed in Norway for the synthesis of nitrates, is distinguished from other electric furnaces by its strength, capacity, and durability. The water-cooled tubes of copper which form the electrodes have an average life of 1,000 hours. In addition to the magnetic deflection of the arc, there are ingenious devices for controlling the entering and issuing gases. The details of these devices are not published, but it is known that they diminish the time during which the oxides of nitrogen formed in the arc are exposed to the temperature of dissociation, and thus greatly increase production.

The methods of converting the nitrous vapors into commercial forms have been the object of careful research and, although the processes are protected by patents, their details are kept secret. The gases pass from the furnaces into oxidation towers, where the nitric oxide is converted into peroxide, and thence into granite towers 66 feet high and 320 feet in sectional area, where the nitrogen peroxide meets a finely divided stream of water. The result is the formation of a 25 per cent solution of nitric acid.

The gas which is discharged from these towers still contains one-fifth of the nitrogen peroxide. Most of this is reclaimed by washing the gas in wooden towers with a solution of lime, sodium carbonate, or potassium carbonate. The gas discharged from these towers contains less than 5 per cent of the oxides of nitrogen formed and this loss is continually being diminished by improvements in the process.

The dilute nitric acid of the granite towers is neutralized with coarsely broken limestone. The resulting solution of calcium nitrate is evaporated by the waste heat of the furnaces. The nitrate is ground and sifted for agricultural use, but is delivered to chemical factories in cakes. The liquid of the wooden towers yields, on evaporation, both nitrate and nitrite of soda (if soda is the alkali employed). Schloesing has invented a method of converting the oxides of nitrogen produced in the furnace directly and entirely into nitrates, no nitrites being formed.

Synthetic nitric acid is almost absolutely pure and is consequently very valuable for many uses, especially in the manufacture of fireworks, for the impurities of commercial nitric acid often produce chemical changes which cause serious accidents.

The most important product of the Norwegian factories is calcium nitrate, which is a far more efficient nitrogenous fertilizer than Chile saltpeter. But the Norwegian product is not likely to lower the cost of nitrogenous fertilizers, for the demand is steadily increasing; and while 1,800,000 tons of Chile saltpeter and 800,000 tons of ammonia sulphate are produced annually, the production of Norwegian nitrate is now only 25,000 tons and is not expected to exceed 125,000 tons in 1911, or 200,000 tons in 1913.

Wealth of the People of the United States.

Heretofore no estimates have been possible concerning the value of property in the United States at the beginning of the Constitutional government. It is, however, feasible to roughly compute all wealth upon the basis of the number of dwellings computed in this report as representing the number of farms or properties having an average value. A reasonably accurate estimate of the value of slaves is also available. The total value of all property in the Republic at the period of the First Census was probably not less than $500,000,000 and not more than $700,000,000. The standards of value at that time were much less than they are now. Hence, in terms of present values, it is probable that all property in 1790 was worth approximately one billion to one billion and a quarter dollars. The total per capita wealth in 1790 was about $171—in New England, $138; in the Middle States, $145; in the South, $217; but on the basis of present money tables these figures should at least be doubled.

A European Zinc Trust.

The zinc producers of Germany, Belgium, and France, with the exception of the Giesche firm, which controls only one-fifth of the Silesian product and cannot become a formidable competitor, have united to form a syndicate, which the five great English establishments will be invited to join. No attention has been given to American producers, as little American zinc is exported. The syndicate will control an annual output of half a million tons of zinc. In the provisional agreement, which is to remain in force until January 1, 1911, the output of each of the firms is determined, and it is stipulated that the production shall be diminished whenever large stocks have accumulated or the market price falls below 19 pounds sterling per ton, and increased when this price is exceeded.

A firm of patent swindlers, operating in this city under the name of Walsh Brothers & Co., has recently been found guilty of using the mails to defraud. The firm posed as an agency for soliciting patents, and those who answered the advertisement were confidentially informed that John T. Sherlock, one of the members of the firm, possessed a special influence with the Patent Department, which gave him an advantage over other agencies. The inventor was thus induced to pay a registration fee, and the only return he received for his money was a small cut of his invention. By this method the firm managed to take in from $500 to $1,000 per week. Sherlock has been sentenced to serve a term of two years in the Atlanta Federal prison and pay a fine of $500, while John Walsh, another members of the firm, must serve eight months in the penitentiary and pay a fine of $100.

THE FLYING GURNARDS.

BY CHARLES F. HOLDER.

When one approaches the Strait of Florida, and even before, against the Gulf Stream, he begins to see the clear blue water dotted with the green weed called gulf weed, the growth which, in the great vortex to the east and south, forms the so-called Sargasso Sea. The writer has seen patches of this weed covering acres of the Gulf near the Florida keys, the vast masses forming homes for many strange and interesting animals ranging from fishes down to barnacles, nearly all so singularly colored as to resemble almost perfectly the weed itself.

The *sargassum* is often broken up into leads, rivers, and streams, as it were, and in which will be found many interesting fishes which seem to seek protection here. Among them is a flying gurnard of great interest and beauty, shown in the accompanying photograph from life.

The fishes are veritable knights of the fin; are armored cap-a-pie, the head covered by a bony cap from which several spines turn backward. The side or pectoral fins are large and winglike, the rays connected by webs presenting an extraordinary surface, and seemingly having all the attributes of a wing. They are beautifully colored as well, and a marked contrast to the ordinary flying fish, which is usually a pure silver below and green or blue above; but the flying gurnard is a resplendent creature ablaze with tint and color.

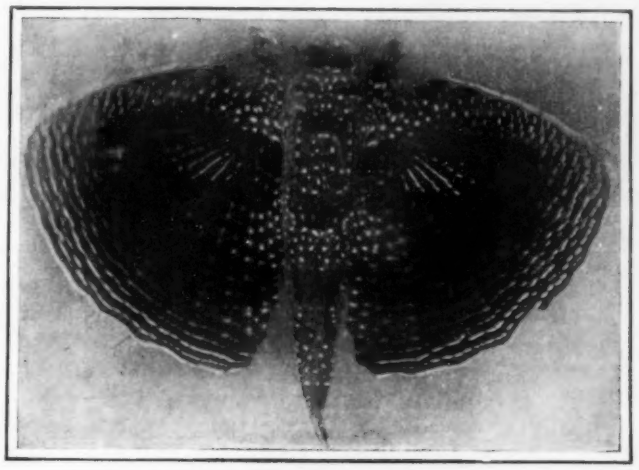
The adult gurnard is about twelve inches long, and I have more than once dodged it as it came flying along the surface. There is a marked variation in color. I have seen them in a vestment of deepest blue; again a crimson, or a combination of both. The wings are often olive green in color, but I have seen them a deep scintillating blue, and often they are green splashed with spots of vivid blue, almost iridescent. The tail is sometimes tinted a pale violet. Such a radiant creature, flashing like a gem in the blazing sunlight, not one, but a dozen, or twenty dashing over the surface, appeals to observers in different ways. The layman who has never seen them before admires the brilliant display, the fish appearing like some dazzling insect as it dashes through the air; and in nine cases out of ten the observer will be willing to take affidavit that the fish is flying, as the fins or wings appear to flutter; but the fact is that the flying gurnard is an animated aeroplane. It dashes out of the water at full speed, spreads its wings and soars, not flies, the rush through the air causing the weblike wings to flutter, giving the impression that the animal is moving by the beating of its wings.

The gurnard, at least so far as my observation goes, cannot fly as far as the California flying fish, which covers an eighth of a mile with ease, yet I have seen a gurnard sail out of sight, have seen it pass over a boat four or five feet from the water, and the fish is often blown aboard vessels, in several instances men being knocked down by it. In one instance known to me, a schooner was plying between some of the keys of the outer reef, but one man being on deck. The men below noticed that the vessel was up in the wind, and ran on deck to find their companion senseless from a wound between the eyes; a gurnard near by on the deck was the explanation. The head of the fish is a most formidable weapon of offense ac a projectile, being as hard as a stone, and reaching backward from it are four long, sharp spines, which have all the appearance of barbs to this living arrow. The head is blunt, rising almost directly from the mouth, altogether giving the gurnard a pugnacious appearance.

In rowing my boat through the *sargassum* at times these beautiful fishes would be seen rising all about; sometimes landing in the blue lanes, again dropping upon the mass of weed to struggle laboriously off into their native element, disturbing various stolid fishes known as *Antennarius*, often found lying prone, so simulating the weed that it was impossible to distinguish them from it.

In parts of the Barbados these fishes are highly esteemed, just as the sculpin, which is scorned in New England, is considered one of the best of edible fishes in California. The natives down in the Caribbean Sea round up the flying gurnards of that region in great seines and take them by thousands. The sight is often of great interest, as when a school is found, and it is surrounded by the big net, the fliers go into the air by hundreds, presenting a most animated picture; the blacks shouting and laughing, and dodging the hard-headed fishes, which dash over the nets, sometimes hitting the natives. The net is either hauled upon the beach, or upon the various boats, which are filled to the brim with gorgeous fishes.

Moseley, the naturalist of the "Challenger," tells an interesting story regarding his experiences with this fish. He was fishing for some larger game when he had a strike, and a flying gurnard dashed into the air, firmly hooked, to the amazement of the angler who, doubtless, never before played a fish in the air.



FLYING GURNARD.

Light spots are blue; dark areas are olive green.

The flying gurnards, at least those observed by me, are surface fishes, preferring to live where they can leap into the air and soar away from their enemies. It is somewhat singular that inventors who are experimenting with airships do not study the flying fish, which is an ideal model, the most perfect soaring machine ever seen or likely to be seen. The pose of the flying fish in "soaring" is never pictured properly in books. Engravings usually show them parallel to the water, but they stand in their relation to the water at an angle of about forty-five degrees, the tail hanging down. When the speed is great the angle is more acute, and *vice versa*. If an airship could be built on the plan of the flying fish, it would be an instantaneous success.

LATRODECTUS—THE POISONOUS SPIDER.

BY ALEXANDER PETRUNKEVITCH, PH.D., HONORARY CURATOR FOR ARACHNIDA AT THE AMERICAN MUSEUM OF NATURAL HISTORY.

All spiders have a pair of poison glands situated in the cephalothorax, and opening by means of a narrow duct near the tip of each fang. (Fig. 1.) Nothing, however, could be more erroneous than to suppose that all spiders are poisonous to man. On the contrary, with the exception of the large *Tarantulæ* (*Therophosidæ*) there is only one genus all the species of which are extremely poisonous. The name of this genus is *Latrodectus*, and it has its representatives in all warm countries. The bite of the *Latrodectus tredecimguttatus*, or the so-called "Malmignatta," has always been dreaded by the population of Italy, and it is probable that the fable of the tarantella dance is based on observations of the convulsions following the bite of this spider, which have been embroidered upon by the vivid southern imagination. *Latrodectus mactans* is one of the commonest neotropical species, but it is found as far north as New Hampshire and to the south as far as Patagonia. The female is only one-third to one-half of an inch long, of a uniform shiny black color. The ventrum is just as black, but there is always a bright red spot on the abdomen, by which the species may be at once recognized. (Fig. 2.) The male is much smaller and harmless, since it cannot bite through the human skin. The spider makes its loose web under stones, is of sluggish nature and of nocturnal habits.

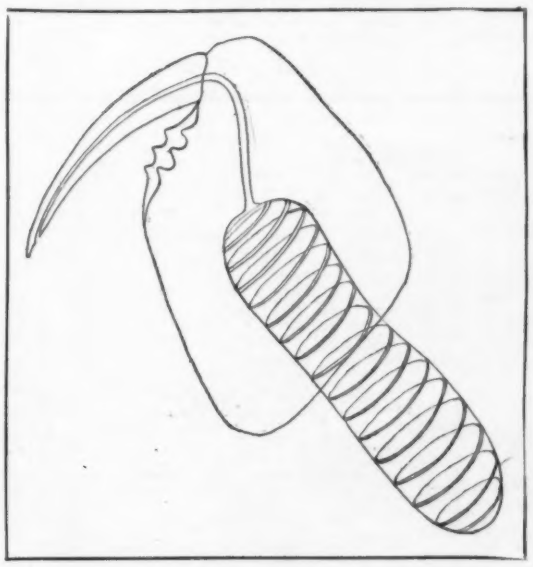


Fig. 1.—Fang of the Latrodectus, showing poison duct.

Fig. 2.—Female Latrodectus, identified by red spot on ventrum.

LATRODECTUS—THE POISONOUS SPIDER.

For a long time nothing definite was known about the poison of *Latrodectus*, but grewsome stories of the sufferings caused by the bite were told, and occasionally authentic cases of sickness and even death were recorded in the old and new world. In 1901 Prof. R. Kobert of Rostock published his research on the subject. His method consisted in extracting the poison by means of a salt solution, and injecting it into the blood system of an animal. In this way he found that the extract from a single spider would suffice to kill a thousand cats.

In 1899 an expedition under the auspices of the Russian Department of Agriculture started for the South Russian steppes, and spent several years in the study of the *Latrodectus Karakurt*. Mr. Rossikov, who was at the head of the expedition, gives a detailed account of the results of their investigations (printed in 1904). He also describes the effect of the bite on one of the members of the expedition, a Kirgiz interpreter. Like other species of *Latrodectus*, *Karakurt* does not show much inclination to attack, and prefers to run away. After a month of unsuccessful attempts to induce the spider to bite him, Mr. Sczerbina, a member of the expedition, came to the conclusion that the spider is harmless, and decided to take photographs to prove his assertion. Six spiders were placed on the denuded breast of a man, while Mr. Sczerbina proceeded with the photographing. In the midst of this occupation one of the spiders ran down the arm of the interpreter, and bit him a little above the hand articulation. A moment later terrible pain began to spread from the arm through the entire body of the victim. No swelling of the arm ensued, but inside of five minutes the pain became intolerable. The patient was trembling all over his body, the eyes were dull, the face had an expression of terror. Half an hour later convulsions and cramps set in accompanied by vomiting, oppressed respiration, and cold sweat. At times the patient became unconscious, and again cried out with pain. The doctor arrived one hour after the accident. The cramps continued for nearly six hours. Only on the evening of the following day was the patient strong enough to be removed to a hospital. Three weeks later he was dismissed apparently well, but still suffering from extreme weakness and constant cold perspiration on the forehead and breast.

Other experiments have been made since then by different investigators. They all show that the poison of *Latrodectus* acts as a hæmolysine, i. e., destroys the red blood corpuscles and coagulates the fibrin. Unlike the poison of bees, wasps, scorpions, and tarantulas, it has no local effect, but affects rapidly the whole organism. This extreme rapidity (all symptoms are in full swing in less than five minutes) precludes in the opinion of some medical authorities any other but symptomatic treatment. It was, however, found that the injection of hypochlorite of lime—$CaOCl_2$—has a very beneficial effect, and sometimes saves the lives of camels, which otherwise succumb not seldom to the poison of the spider. Still more recently Mr. Sczerbina has produced an antitoxic serum from the blood of camels, which when injected not later than twenty hours after the bite greatly relieves the pain, and promises to be of very great use. That a good remedy is necessary is shown by the fact given by Rossikov, that in 1905, 1,000 persons were bitten in south Russia, ten per cent of whom, or 100 persons, died. In 1896 394 persons were bitten in one district of the Russian Central Asiatic possessions, and 11 of them died. In the same locality during the same year 738 camels were bitten, resulting in 276 deaths, and 192 horses with 39 deaths.

RECENTLY PATENTED INVENTIONS.

Pertaining to Apparel.

BATHING SUIT.—F. E. LILIEDAHL, Pierce, Neb. This garment is for use by men when bathing in public places. Suits ordinarily worn by men and boys consist of a shirt of woven or knit fabric, and short leg coverings formed integral with the lower portion of the body covering. The woven garment, after exposure to water and the sun, shrinks so as to fit too closely on all parts and this entails indelicate exposure of the person. The invention obviates this objection.

Of Interest to Farmers.

HARROW.—W. A. KELLY and C. W. SMITH, Honolulu, Hawaii. The device relates to a harrow that can be drawn by steam or other power from either end, and one object is to so construct the machine that it will be as light as possible consistent with proper work, and so that the machine will accommodate itself to any character of ground.

SANITARY MILK AND CREAM SAVING DEVICE.—C. C. COUSENS, Springfield, Mass. This device is adapted to be applied to a milk or cream cabinet for saving of the milk or cream spilled while filling glasses and mugs. It prevents the spilled milk from escaping into the ice chamber surrounding the milk can and returns the milk to the can in a clean and sanitary condition.

Of General Interest.

BAG-FASTENER.—L. KAESTNER, New York, N. Y.—The fastener is especially adapted for use on handbags, pocketbooks, chatelaines, etc., and the object of the inventor is to so construct the device that the jaws of the container will be held together not only by the resilient engagement of the ordinary studs, but will also be positively held by a separate and distinct catch, this catch being so positioned that the act of pressing the studs past each other to open the bag will of itself unfasten the catch.

WINDOW.—L. W. PENZER, Richmond, Va. The object of the invention is to provide a new and improved window, having hinged sashes arranged to permit an operator to conveniently open and close the same, or to swing the sashes inward into the room into an approximately horizontal position for cleaning or repairing purposes.

PHOTOGRAPHIC PRESSURE PRINTING FRAME.—J. PRITCHARD and H. PRITCHARD, 167 Rosebery Avenue, London, England. An automatic air exhaust valve is provided controlling an aperture in the back plate and co-operating with a pump to be placed directly on the back plate over the said valve. Packing means are provided for obtaining an air tight closure between the open end of the pump and the back plate. Thus the pump is brought directly on the back plate of the printing frame to be exhausted, and after exhausting the air from the frame the pump can be easily transferred to another frame.

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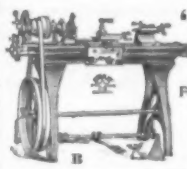

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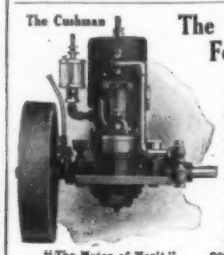

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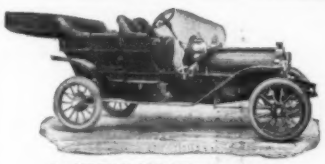

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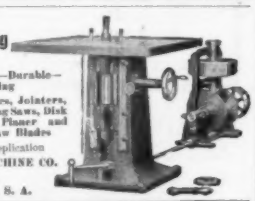

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Wheel. See Buffing wheel.	
Wheel, H. E. Keyes	921,613
Wheel machines, indexing device for, C. Borg	921,071
Whiffletree hook, T. Morcom	921,267
Window screen construction, J. G. Hudspith	921,405
Wire coil making machine, J. F. Marsolais	921,425
Wire support, T. P. Chandler	921,362
Wire working machine, G. B. Smith	921,016
Work support, J. H. Lesh	921,419
Worms, apparatus for cutting globoid, A. T. Collier	921,593
Wrench, E. Hagerstrand	921,106
Wrench, A. C. Allen	921,335
Wrench, W. H. Dawson	921,643

A printed copy of the specification and drawing of any patent in the foregoing list, or any patent in print issued since 1863, will be furnished from this office for 10 cents, provided the name and number of the patent desired and the date be given. Address Munn & Co., 361 Broadway, New York.

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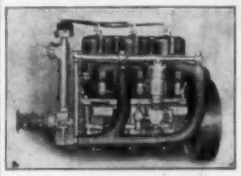

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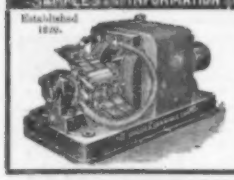

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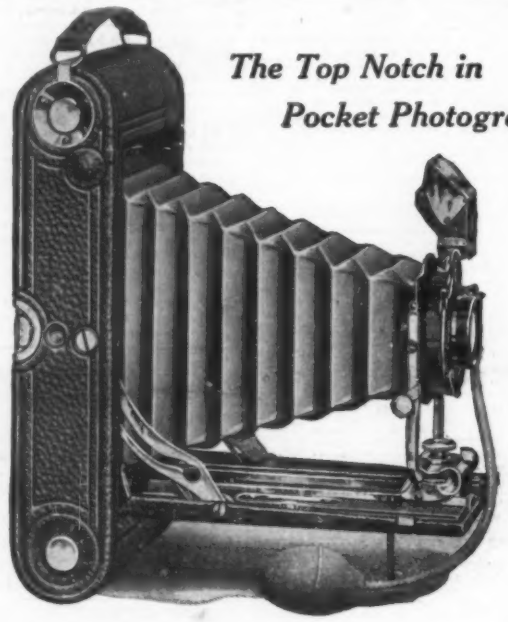

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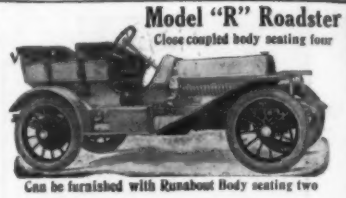

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